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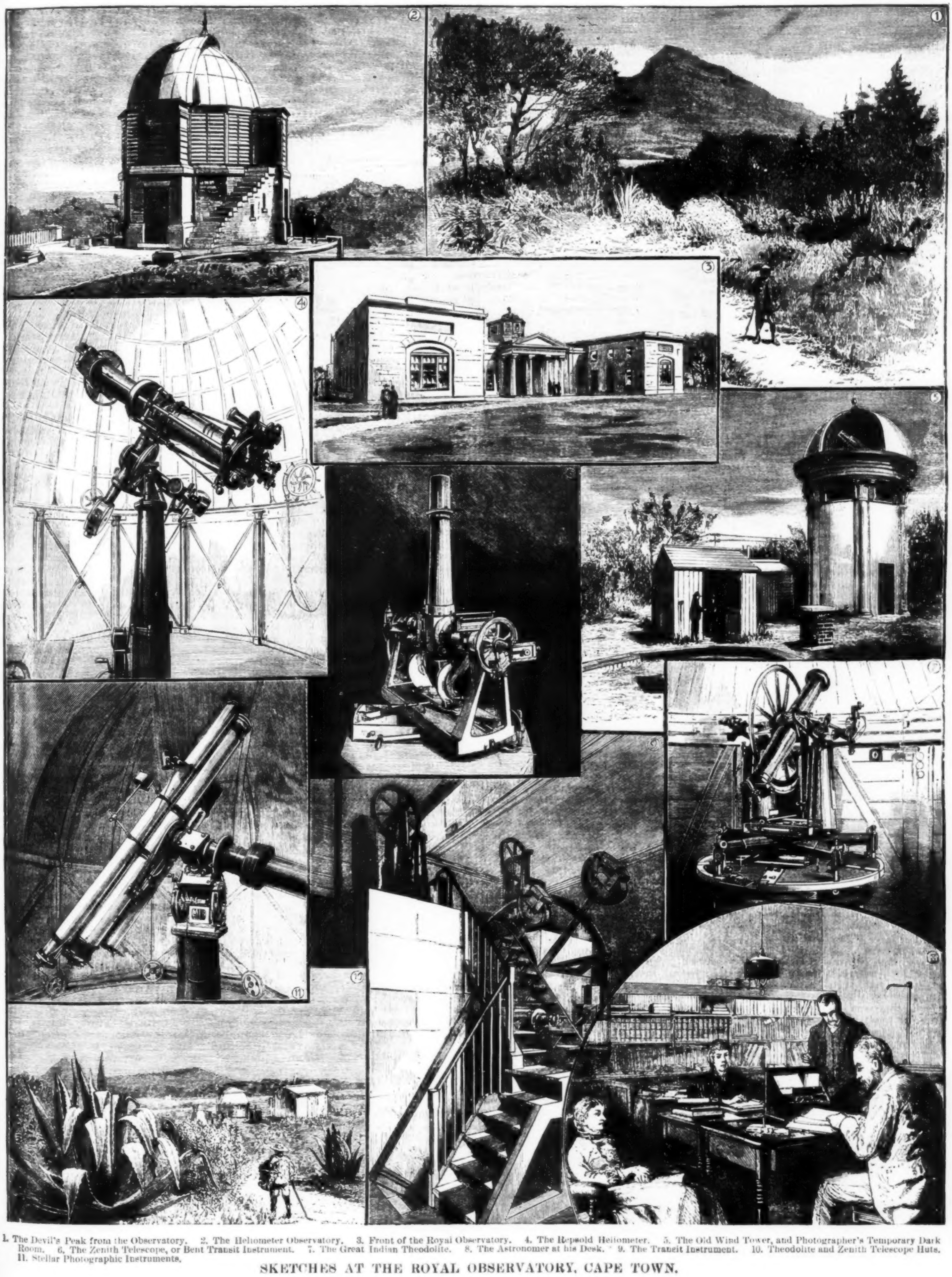


1. The Devil's Peak from the Observatory. 2. The Heliometer Observatory. 3. Front of the Royal Observatory. 4. The Repsold Heliometer. 5. The Old Wind Tower, and Photographer's Temporary Dark Room. 6. The Zenith Telescope, or Bent Transit Instrument. 7. The Great Indian Theodolite. 8. The Astronomer at his Desk. 9. The Transit Instrument. 10. Theodolite and Zenith Telescope Huts. 11. Stellar Photographic Instruments.

SKETCHES AT THE ROYAL OBSERVATORY, CAPE TOWN.

AN ASTRONOMICAL SEASON.

The year 1892 has seen no comet of the season; but it has had several astronomical celebrities. Mars, whose canals have excited a more universal interest than that of Manchester; Jupiter, which, even if it be scarcely so interesting to the public, will at all events be more in the public eye so far as Europe is concerned. Jupiter, the coming professional beauty among the planets, has this advantage over Mars, which it supersedes—that it is to the north of the equator, and, therefore, assumes a considerable elevation in the heavens. Mars is further south than the sun at Christmas, and, therefore, just skirts our horizon. Any fresh knowledge that astronomers may gain of our nearest neighbor will most likely be forthcoming from the observatories in the United States, whose position gives them better facilities for observation; and, perhaps, from the observatory at Cape Town. The Cape observatory is not so well equipped as that at Mount Hamilton, or perhaps even at the Washington observatory; but the clearness of the atmosphere there is especially favorable to observation.

The importance of an observatory is sometimes estimated by the power of its refracting telescope, which, so far as the expression "power" has any meaning, is to be measured by the diameter of its object glass. There has, for many years now, been some honorable rivalry between the nations as to which should possess the greatest refracting telescopes. Among the largest instruments successfully completed is that erected a few years ago by Sir Howard Grubb at Vienna. Its object glass is twenty-seven inches in diameter. But the Russian astronomers have procured from Messrs. Alvan Clark, of Boston, Massachusetts, a glass thirty inches in diameter; but the crowning achievement of the firm has been the great Lick refractor, which is thirty-six inches in diameter. But the refracting telescope is only one of the many instruments which are indispensable to a great observatory, viz., the heliometers, transit instruments, meridian circles, mural circles, theodolites, micrometers, microscopes, and other inventions of earlier or later discovery which make astronomy so exact a science that the thread of a spider's web is not fine enough for the observer, and the most perfect of mechanical contrivances are in his estimation only agglomerations of imperfections. It is impossible, and would not be interesting, to give any detailed account of these in the scope of a short article; it will perhaps be sufficient to define some of the instruments upon which the Cape Town observatory prides itself. The heliometer is an instrument which can be used to measure the angular distance between objects too far apart for measurement by ordinary methods. It is a telescope with its object glass cut in half along a diameter. One or both of these halves is movable transversely by a screw. Each half gives a complete image of the object. The measures are effected by observing how many turns of a screw convey the image of the star formed by one-half of the object glass to coincide with the image of the planet formed by the other. Many observatories have their own special work. The observations of stars at the observatories of Greenwich, Paris, Washington, and Oxford are mainly directed to the most accurate determination of the places of a limited number of stars and the deduction of their proper motions by comparison with previous results; at others differential observations of large numbers of stars are made, with the object of making a sort of "survey" of the heavens. A good many observatories in Germany and America make differential observations of comets and small planets, as referred to comparison stars; and some—Pulkowa, for instance—devote themselves to the measurement of double stars with the micrometer. Of late years two new subjects have been introduced into the routine of observatory work—photography and spectroscopy; and in both these departments we owe many important discoveries to Cape Town. Our illustrations are from photographs sent us by Mr. C. R. Woods.—*The Graphic, London.*

DOUBLE AND MULTIPLE STARS.

By Wm. H. Knight.

When the aid of the telescope was brought to bear upon the study of the fixed stars, one of the marked features of their arrangement was the prevalence of pairs. So many of the larger stars were found to have a neighbor in close proximity that these groups came to be classed as double stars, and were carefully studied and catalogued.

Of the 600,000 stars of the first ten magnitudes, about 10,000, or one out of every 60, has one or more companions within 30 seconds of arc, or so close as not to be distinguishable from the principal star without the aid of an instrument. This proportion is many times greater than could possibly be the result of a chance alignment of two unequally remote stars in the same range of view.

It was not long after Sir William Herschel began his astronomical researches before changes in the relative positions of some of these double stars were noted, and in 1802 he put forth the startling theory that they were physically related to each other, and revolving around a common center, thus constituting systems resembling our solar system, and proving the existence of the law of attraction among those distant orbs.

This analogy to our own system is rendered still more striking by the occurrence of two or more of these companions in some of the double star groups, corresponding to the several giant planets wheeling in their distant orbits around the sun. At the same time we must admit that all these double star systems, so far as we have made their acquaintance, present features which contrast strongly with some of those characteristic of our own system.

In the first place, the sun is the only self-luminous body in the solar system, whereas a non-luminous body, or one shining by reflected light, would be invisible at the distance of the nearest fixed star, if it were as large as Sirius himself.

Secondly, the components of these stellar systems have very eccentric orbits. The average eccentricity of the planetary orbits, says Mr. See, a German astronomer, is only one-tenth that of 50 binary orbits thus far determined.

And thirdly, the large relative size of their companions is a prominent characteristic of all double stars. Our sun has no planet at all comparable in size with the least of the companions in any system visible in the telescope. The two components of 61 Cygni are nearly equal. The companion of Algol is about one-half the size and mass of its principal. That of Sirius is about one-third. Whereas the sun is about 1,000 times larger than the giant planet Jupiter and 700 times larger than the aggregate mass of all its planets put together. At the same time each of the planets is attended by comparatively very small satellites. The single exception to this rule is that of the earth and its satellite, their diameters being as one to four and their volume as one to 50. So that, viewed from either of our neighbors, Venus or Mars, the earth and moon present the aspect of a pair of planets of unequal size, alternately approaching and receding from each other.

But how, it may asked, can we determine the masses of two objects so remote that they are only resolvable into separate stars, or points of light, by the aid of the telescope? Three elements are necessary to the solution of this problem, namely, the distance of the double stars from the earth, the distance of the components from each other, and their period of revolution around each other. Of but few stars have we been able to learn all these particulars. We know that there are 10,000 double and multiple stars. The orbits of about 60 have been approximately determined by observation. But of less than a dozen do we know their distance from the earth, and without that knowledge we cannot calculate their actual distance from each other, and so cannot compute their masses. An exception to this rule will be noted further on.

It was not till the year 1838 that Bessel succeeded in finding a parallax to the nearest fixed star in the northern heavens, known as 61 Cygni. It is a small 5th magnitude star in the Swan, and is distant seven light years from the earth, that is, it requires seven years for its light to reach the earth.

But as long ago as 1750, 61 Cygni was known to be a double, and subsequent observations showed that its two components would complete their revolution in 782 years. When, therefore, their distance from the earth was known, it became an easy problem to measure their distance from each other. Here, then, we had the three elements: distance from the earth, distance from each other, and orbital motion, from which data it was easy to deduce their combined mass. This was ascertained to be about one-fourth that of our sun, and as their orbits were nearly equal in extent, it was inferred that their respective masses were also equal. Each of these orbs, then, is a self-luminous world, about one-eighth the size of our own sun, or 100 times larger than the great planet Jupiter.

Among the double stars are many pairs of which the two components have different colors, the brighter one generally being orange, red or yellow, and its companion blue, green or purple. In the beautiful system of Gamma Andromeda, the largest central sun is orange, and, seen through a small telescope, the companion is an emerald green. But applying a higher power, the green star is seen to be double, and is built up, so to speak, of one blue and one yellow star. Imagine the effect such a combination of colors must have upon the planets revolving about either of the stars! It is as if our sun shone with an orange light and distant Neptune were enlarged to the size and brightness of a veritable sun shining with a yellow light, and circling around the latter were a companion of nearly equal dimensions shining with a blue light. We should then occasionally have only the orange light of our own central sun. At other times we should have only the blended light of the two companions, producing a green effect upon the landscape. On still other occasions, only one of the companions would be above the horizon, and then our atmosphere would be bathed in a clear yellow or a bright blue. Again, a most curious effect would be produced upon the moon. One portion of its visible surface might be reflecting the orange light of the central sun, while the remaining portion is colored into segments of green, yellow, and blue, resulting from various combinations of the companion suns.

As Neptune is the morning or evening star during the entire year, so these hypothetical colored suns would invade our nights, making portions of them as light as day, thus seriously interfering with the study of sidereal astronomy, as there would be a very limited period when the stars would not be obscured by sunlight.

One of the finest examples of complementary colors in double stars is furnished by the splendid pair called Gamma Leonis. It is the bright star of the second magnitude in the handle of the Sickle in the constellation Leo, which comes to the meridian in March and April. The larger star is described by Struve as a golden yellow, while its companion is a reddish green. The pair is easily defined, and can be seen as a double through any te scope of moderate power, and will be found well worth the search. The Gamma Leonis system, though very brilliant, is so remote that it furnishes no sensible parallax, but its period has been approximately determined as 407 years. The companion has not, then, performed quite one revolution since Columbus set sail for America. Among other combinations are yellow and purple, green and blue, orange and green, orange and blue, white and blue, and yellow and sapphire blue. The latter combination prevails in the beautiful pair known as Beta Cygni, a third magnitude star in the Swan.

What is the cause of the various colors which distinguish and adorn these interesting doubles? It has been noticed: (1) That in double stars of short period and nearly equal dimensions, the components have nearly the same and unvarying tints. (2) In those of long periods and very elliptical orbits, the principal star is often pale yellow when the companion is at periastron, or nearest approach, and of a deep yellow or orange in other positions. (3) The companion follows the principal in its fluctuation of color, and often surpasses it at apastron or point of farthest separation.

Now there is a good deal implied in these observations that is of great interest to the physicist. Note that when the stars have a uniform distance there is a uniform color, but when, owing to highly elliptical orbits, the distance varies materially, there is a corresponding change in color which seems to show a corresponding change in heat intensity. In other words, when the two components approach comparatively close, their color is that which represents a fiercer combustion, and when, on the other hand, they withdraw from each other's vicinity, their gases seem to burn with less energy, and therefore with a milder radiance and higher color. Does not this sequence of causes and effects show that these suns are great electrical dynamos, acting upon each other with an energy proportioned to their proximity?

But we have another exhibition of this tremendous electrical energy in the new star which recently blazed forth in the constellation Auriga. It made its first appearance last December as a faint telescopic object, but gradually increased in brightness, till in the month of February it showed as a naked eye star of the fifth magnitude. "Its aspect," says Miss Agnes Clerke (a brilliant English writer on astronomical topics), "was perfectly stellar. It rays emanated from a sharp point. But," she continues, "let us hear the dictum of the spectroscope in this matter. The light of Nova Aurigæ, unrolled by prismatic dispersion into a rainbow-tinted ribbon, presented a dazzling spectacle. Splendid groups of bright lines stood out from a paler background; the red ray of hydrogen—Fraunhofer's C—glowed, as Mr. Espin remarked, like a danger signal on a dark night; a superb quartet of rays shone in the green; shimmering blue bands and lines drew the eye far toward the violet; the characteristic blazing spectrum, in fact, of a new star was unmistakably present. It was marked, however, by one extraordinary peculiarity in the coupling with dark lines of all the bright rays conspicuous over its entire extent. Each lustrous member of the great hydrogen series carried a black shadow on its blue or more refrangible side."

Astronomers watched this strange appearance with keen interest and sought to interpret its meaning, and the answer was in the highest degree surprising. These extraordinary displacements of the spectrum lines indicated, according to Dr. Vogel, an enormous velocity of approach, coupled with a tremendous velocity of recession. The bright lines testified that a luminous body was rushing away from the earth with a velocity of 420 miles per second, while the dark lines proclaimed that another bright mass was rushing toward the earth with a speed of 300 miles per second, and the two blazing worlds were separating at the rate of 720 miles per second.

Now may we not fairly infer that the fierce outburst of energy which rendered Nova Aurigæ visible a few months ago was caused by two flaming worlds, flying from differents quarters of the universe, chancing to pass in close proximity at that particular time, and by mutually acting upon each other as great electrical dynamos, stimulating to unwonted action the energies of combustion?

"There is good reason to suppose," says Miss Clerke, "that every such body is in a state of powerful electrical excitement, and creates in its neighborhood a very extensive magnetic field. A second body entering this field, and sweeping with prodigious speed across the lines of force traversing it, must then give rise to powerful electrical agitations. And here, perhaps, may be found the chief source of the amazing displays registered by astronomers as new stars. Gravitational disturbances, too, of the kind that raise tides in terrestrial oceans, but immensely exaggerated in degree, no doubt come in as auxiliaries."

The distance of Nova Aurigæ, which thus shone forth among the remote stars of the Milky Way, was believed to be not less than 100 light years from the earth. Our sun would barely be visible as a telescopic star at that distance. It passed through its wonderful transformation then, blazing forth with the brightness of a thousand suns, more than a century ago, during the closing scenes of the revolutionary war, or while Napoleon's armies were overturning the thrones of Europe.

Among the recent notable achievements of astronomers is the discovery of double stars which are so close and distant that they cannot be separated by the most powerful telescopes. A fine example of this class of doubles is Beta Aurigæ, a bright star above the head of Orion. The velocity of the components of this interesting double, which are nearly of equal dimensions, is about 150 miles per second, or nine times faster than the earth flies in her path around the sun. Their orbit is nearly circular, and about 16,000,000 miles in diameter, or less than one-fourth that of the orbit of Mercury. Their combined mass is only from 1-10 to 2-10 that of the sun. Even then, each of those brightly flaming worlds is 100 times larger than Jupiter. which has a volume 1,300 greater than that of the earth. But it may be asked, How are we able to give all this data of period, mass, and dimensions of orbit, of two objects so distant and so close that the best eye and the best intrument cannot separate them? Again, the spectroscope is the wonderful instrument which reveals all these facts. At certain times the spectrum of this star is single, like that produced by other single stars. After the lapse of two days certain lines in the spectrum are duplicated and divergent, resulting from the fact that at that time one of the component suns is in a portion of its orbit when it is flying away from the earth with the enormous velocity of 150 miles per second, while its fellow is approaching the earth with a corresponding velocity. After the lapse of another two days the components have reached that portion of their orbit when each is moving across the line of vision, though in opposite directions, but as there is neither approach nor recession, the lines in the spectrum are simple and single. Our knowledge, then, amounts to a moral certainty that two bodies are revolving about each other where the keenest eye and the best aided vision discerns but one. We know further that the velocity of each is 150 miles per second, therefore their respective masses must be equal. From these data the mathematician was able to calculate size and distance apart of the two bodies.

Another striking example of this kind is the recently determined quadruple in the Great Bear—the well known Mizar in the handle of the Dipper. This was the first recognized double star, having been divided by Riccioli, at Bologna, in 1650. The components are 14" apart, and have a period roughly estimated at 10,000 years. These are escorted at a distance of 11½' by Alcor, visible to the naked eye, thus forming a triple having a period, purely conjectural, of 190,000 years. But the special interest is centered in the principal, for the spectrum, according to Professor Pickering, of Harvard, shows its bright lines to be periodically

doubled, indicating the existence of two suns, moving with a velocity of 50 miles per second, about a common center, in a period of 104 days. They are nearly equal in mass, with nearly circular orbits, about 143,000,000 miles apart, and together equal to 40 suns.

Here, then, is a strange system, consisting of two gigantic suns about as far apart as the diameter of Venus' orbit, wheeling about a center in three and a half months, attended at a remote distance by another brilliant orb, slowly and majestically revolving around both the central suns in a period that is only to be measured by the lapse of ten long millenniums. And these again, vast as their masses and distances are, act as a unit around which the great star Alcor moves in a stately orbit requiring hundreds of thousands of years to complete a revolution.

But these are not the only instances where an unseen companion has been detected. Algol, the wonderful variable star in Perseus, was suspected to have a dark companion which partially eclipsed it at a certain point in each revolution of a little less than three days. As about five-sixths of its light is eclipsed, of course the companion must be comparatively a very large body, which, on the other hand, requires a considerable motion of the primary if the two bodies revolve about a common center. Applying the spectroscope, then, to the primary, we find that at certain points in its orbit it is receding from us and at the opposite point it is approaching, and from the data thus obtained, Professor Vogel, of the great German observatory at Potsdam, determined that the diameter of Algol is 1,061,000 miles, that of its companion 830,300, and the distance from center to center, 3,230,000. Orbital velocity of Algol 26·3 miles and that of the dark companion 55·4 miles. Mass of Algol, four-ninths that of the sun; mass of the companion, two-ninths.

But there is still another case of an unseen companion being discovered and its orbit determined, before it was seen through a telescope, and before the spectroscope had come into use. Many of the stars, perhaps all of them, have what is called a proper motion, that is, an apparent motion through space. This motion is generally so small that only the most careful observations, prolonged for many years, will detect it. In the case of the brilliant star Sirius, however, the proper motion is very perceptible. That star is speeding rapidly along its undetermined course at the rate of 27 miles per second.

But it was noticed, after comparing long-continued observations, that this motion was not uniform as to velocity. In other words, the great star, careering so grandly through space, was subject to strange perturbations. It seemed to halt, then hasten on in its course. Some invisible body of enormous dimensions was evidently exerting a powerful influence over Sirius.

In 1844 Bessel, a German astronomer, who had discovered the parallax of 61 Cygni, announced his belief that Sirius was attended by an invisible, giant companion, and that both bodies were revolving round a common center, performing their revolutions in about fifty years. This was two years before Leverrier demonstrated the existence of the unseen planet Neptune by noting the perturbations of Uranus.

About eighteen years later Alvan Clark, the telescope maker, had just completed an 18½ inch lens (the largest then existing) for the Chicago observatory, and in order to test its quality his son directed it to Sirius, which was shining on that February night in an unclouded sky. Suddenly the latter exclaimed, "Why, father, Sirius has a companion." The old telescope maker eagerly looked, and, sure enough, there it was, a faint star of the ninth magnitude, hitherto unseen, and in close proximity to the great Sirius.

The discovery was promptly announced to the world of astronomers, and presently word came back that the new star occupied the precise position required for the companion according to Bessel's hypothesis, put forth eighteen years previous. But Bessel, whose genius had demonstrated the existence of this companion, died before its discovery, and therefore never had ocular proof of his theory.

This companion sun of Sirius is found to move in a highly elliptical orbit, extending at apastron to a distance from its principal equal to one hundred millions of miles beyond the distance of the planet Neptune from our sun. Now Neptune revolves about the sun in 165 years, but the Sirian planet, still more remote, revolves about its primary in 58 years. This means that the attractive force of Sirius, or rather of the combined suns, is far greater than that of our sun and its distant planet, and that their combined mass is correspondingly greater, and it is found to be about 3½ times that of the sun, of which one-third belongs to the companion.

But while these two bodies are so near alike in mass, note the remarkable difference in brightness. Sirius is 60 times brighter and perhaps 60 times hotter than our sun, while its great companion shines with such a feeble light that it would take 160 of them to equal our sun in splendor.

Now may we not reasonably suppose that Sirius and its companion are each attended by a retinue of planets and their satellites? If so, what a variety and complexity of effects would be produced by their peculiar relations to two suns in place of one! If there is a planet revolving around Sirius as near to that body as the earth is to the sun, it would be far too hot to support life. Suppose our hypothetical planet is as far removed as Jupiter. Owing to the enormous mass of Sirius, it would revolve around that orb in about three years instead of twelve, moving with a velocity of 40 miles per second, even then receiving more light and heat than the earth does from the sun.

But the dweller on that planet of Sirius would rejoice in the possession of two suns—the brilliant Sirius, shining with a splendor beyond anything we have ever witnessed, and the companion sun, about as far away as Neptune, shining with a milder radiance, about equal to the light of sixty full moons. At times both suns would be shining in the same sky; at other times only the companion sun would illuminate that half of the planet turned from Sirius, but the light then received would be nearly equal to broad daylight on a cloudy day.

But suppose our imaginary planet were revolving around the companion instead of Sirius, then its inhabitants would have two suns of about equal splendor, though Sirius, owing to his greater distance, would present a smaller disk than his companion. But owing to the high ellipticity of the companion's orbit there would be times when the imaginary planet would be very inconveniently near the great hot central sun, and other times when it would be correspondingly remote, thus producing great contrasts and vicissitudes of climate.

If space permitted, we might indulge in other interesting speculations; for instance, we might consider the probable effects of the mutual attractions of two great bodies, so situated, upon the motions of a third body revolving around one of them. Likewise the effects upon animal and vegetable life on worlds where sunshine prevails for long periods throughout the twenty-four hours, or whatever time constitutes the diurnal rotation.

Then, again, it is not beyond the bounds of probability that some very remote planet, or burned out sun, far out on the confines of the firmament known to the Sirian system, may be revolving around the common center of the two gigantic suns, paying due allegiance to each as it careers along its orbit.

Indeed, the well-known triple star Zeta Cancri furnishes a notable example of this class. This star, according to a recent paper of Seeliger, an astronomer of Munich, consists of a close pair of stars about one second apart, each of the fifth magnitude, accompanied by a third star of nearly the same size, at a distance five or six times as great. These two stars of the close pair revolve around their common center of gravity in fifty-nine years, while the more distant star moves around the pair in the same direction in a period of about 700 years. But the great Russian astronomer Struve has noted irregularities in the distant companion which can only be explained by supposing that it has a dark companion, nearly as massive as itself, and that the two revolve around their common center in about twenty years. It will be seen that this dark companion transforms the triple into a quadruple star.

We have another interesting example of a quadruple in the fine star Epsilon Lyræ, which a small telescope expands into a double, but when a still higher power is used, each component unfolds into a pair of stars circling gayly about each other, and the two distant pairs majestically sweeping about a common center in a period that may be measured by thousands of years.

A still more complicated system is the double treble star (so called by Herschel) known as Sigma Orionis. It is a third magnitude star, just below the middle star in the belt of Orion. Herschel separated the two components into three stars each in 1779. Barlow continued the resolution and found that each component was a quadruple. Burnham in 1888 added to the complexity by discovering that the principal member of the large group is a close double, only a quarter of a second apart.

Here then is a star, single to the naked eye, and successively transformed into a double, double treble, double quadruple, and finally a double group, one of which contains five stars, and these successive transformations are produced by adding to the power of the instrument and the skill of the observer. And it is remarkable how much is due to the latter quality. Burnham made some of his most useful discoveries with a six inch lens.

In astronomical research, as in other branches of science, the best work is done by specialists. The field is so vast, the detail so voluminous, and the accumulated material so abundant, that each investigator, in order to hope for success, must select a limited and special field to work in. Accordingly we find certain astronomers studying the sun, others the planets, others devote themselves to the discovery of comets. One astronomer is special authority on the asteroids, another on meteorites. Several devote themselves to the investigation of nebulæ, others to variable stars, and still others to the consideration of double stars. Sir William Herschel was the first to discern the importance of having a complete catalogue and record of double stars, and was the first to announce the probability of a physical connection existing between their components. His son, Sir John Herschel, continued the same line of investigation, extending his researches to the southern hemisphere, where he added upward of 1,000 double stars to his father's catalogue.

Contemporaneous with the younger Herschel was the elder Struve, who was director of the best-equipped observatory in Europe, at Pulkowa, near St. Petersburg. He was an enthusiast on double stars, discovered a large number, and computed the orbits of many of them. He was also succeeded by his son, Otto, who has proved a worthy successor in the same field of research and a most successful investigator, for he is equipped with the largest refracting telescope in Europe, having a 30 inch lens, only 6 inches less than that of the great Lick telescope.

But the most remarkable results in double star investigation during the last twenty years have been achieved by an American astronomer, and largely with an instrument of very moderate power, having only a 6 inch lens. His success was the result of extraordinary skill in observing. Mr. S. W. Burnham, recently of the Lick Observatory, but now residing in Chicago, has discovered and catalogued upward of 1,000 new doubles. Some of them are difficult objects in instruments of higher power than the one he used, when a less skillful observer is at the eye piece.

Other prominent astronomers in this field of research are Edward C. Pickering, at Cambridge, Asaph Hall, at Washington, Dr. Doberck and H. C. Vogel, in Germany, and J. E. Gore, in Great Britain.

DIRECTION AND VELOCITY OF WINDS.

To the Editor of the Scientific American:

In regard to your answers in the SCIENTIFIC AMERICAN of March 26 last, to the queries of O. A. C. [4162] and C. R. W. [4167], respectively, concerning the directions and velocities of the winds, will you kindly let me add to your answer?

The theory you mention, that of the unequal distribution of the sun's heat and the motion of the earth on its axis, partly accounts for the direction and velocity of the upper air currents.

I say partly, because other authorities have proved to their own and the satisfaction of others that the above named factors are not the only causes for the movement of our upper atmosphere.

But, in reading over the aforesaid queries, I thought that perhaps your correspondents referred to the lower air currents or local, variable winds of our latitude, and write with that understanding.

If I am mistaken, I hope this may interest some one else.

An old definition of variable winds says that they are winds blowing under no fixed law. Nothing could be further from the truth.

Other authorities attempt to account for variable winds by changes in temperature owing to different kinds of soil, and other causes, such as bodies of water, clouds, forests, mountains, etc.

While these causes may be sufficient in other latitudes and countries, they will not account sufficiently for our variable winds.

The principal cause of the variations in direction and velocity of our lower atmosphere in this region is nothing more than our low area storms, whose general direction across the country is from west to east, with a few exceptions.

These disturbances or depressions in the atmosphere are produced by really unknown causes, although several theories have been advanced.

The lower atmosphere flows toward this disturbance in equilibrium at angles varying from 0° to 90°, with an average of 45°, depending on the distance from the storm center, the angle being greatest near the center.

The air flows around the center of the disturbance in a direction contrary to the movement of watch hands, like the water around a whirlpool, and as storms, or areas of low pressure, travel across the country at an average rate of 32 miles per hour the year around, we can account for the rapid changes in the direction of the wind.

However, we know that the above rate of storms will not account for the velocity of our winds, which often blow at a rate of from 40 to 60 and occasionally 80 miles per hour.

The velocity of the wind depends on the intensity of the storm and steepness of the depression.

Nature is always trying to maintain an equilibrium in the atmosphere, as in everything else.

Just as the level of a body of water, broken by dipping a quantity out, is restored, so nature tries to restore the equilibrium of the atmosphere disturbed by the storm, and causes the atmosphere to flow toward the disturbance at a velocity equal to the whirl and steepness of the depression.

Calms in our latitude are, as a rule, found between two storms of nearly equal intensity and are chiefly caused by the two masses of air of the same velocity, which would naturally flow around each storm, meeting, and each counteracting the force of the other.

In the above I have tried to explain the variability in direction and velocity of our lower atmosphere, and if you will give this article space in your valuable paper you will greatly oblige D. P. QUELOS.

Cleveland, O.

PLANTS CAPABLE OF YIELDING TANNING MATERIALS.*

By F. E. MAFAT.

Algarobilla.—The pods of different species of *Prosopis*, containing 60-65 per cent. of tannin; imported from South America, particularly Chili.—Leguminosæ.

Alder (*Betula Alnus*, Linn.).—In Europe *Alnus glutinosa* and *Alnus firma*, and in Japan *Alnus firma*, are indigenous. The bark, leaves, and fruit contain 13 to 15 per cent. of tannin; the 36 per cent. given by some authorities may be doubted. The Japanese alder contains 25 per cent. of tannin and colors the leather but little; the European alder is used in Russia and gives a deep color.—Betulaceæ.

"*Arbousier*" (*Arbutus Unedo*) grows in Europe; its leaves are used for tanning in Asia Minor and contain as much as 36·4 per cent. of tannin.—Ericaceæ.

"*Airelle-Myrtille*" (*Vaccinium Myrtillus*, Linn.).—This plant, more commonly known as bilberry, is abundant in France, Germany, and England. Its tannin is rapid in its action, and 3·5 kilos. of the dried and ground plant will make 1 kilo. of sole leather in a short time. The plant is best pruned like sumac, the leaves are not affected by moisture when gathered, which cannot be said of oak bark.—Ericaceæ.

Alcornoque (*Bowdichia virgilioides*, Humboldt) is South American; the root, wood, bark, and leaves contain tannin.—Leguminosæ.

Acacia.—Various species of acacia yield the fruit or pods known as balibabalah, cassia grains ("grain de cassier"), bablah, neb-neb, and Indian pods ("gousses de l'Inde"). Bablahs were first imported into Europe in 1830 as a mordant; the percentage of tannin in them is from 25-32, according to species. The exporting countries are India, Egypt, Nubia, Syria, Arabia, Senegal, and Mauritius. Acacia extract contains a strong free acid, a tannin analogous to that of nut galls, and a large quantity of a calcium salt.—Leguminosæ.

Andromeda.—Several species grow in Lapland and North America, where they are known as "sour tree." The wood contains 4-8 per cent. and the leaves 10 per cent of tannin.—Ericaceæ.

Birch contains a tannin in wood, bark, and leaves which colors iron salts green. Davy gives 1·675 per cent. as the tannin contents, Villon, 3 per cent., Fraas, 5·32 per cent.—Betulaceæ.

Bennet (*Geum urbanum*, Linn.) is wild in Central and Southern Europe; its roots, leaves, and flowers are astringent, and according to Tromsdorff contain 42 per cent. of tannin free from gallic acid; others, however, give 4 per cent. in the whole plant.—Rosaceæ.

Bistort (*Polygonum Bistorta*) contains in its roots, stem, flowers, and leaves "bistortannic acid" and a yellow coloring matter assimilable by hides; it haunts the marshy land of Southern France.—Polygonaceæ.

"*Behen rouge*" (*Statice latifolia*, Smith) grows in Persia, the Caucasus, etc. Its roots are used in Southern Russia as tan for skins, to which it imparts a dull, ocherous, red color.—Plumbaginaceæ.

"*Bois doux*" (*Inga vera*, etc.) is a tree of Mexico, Guadeloupe, and the Indies, where it is known as cooroocoopully; its wood and bark are tanniferous.—Leguminosæ.

Bauhinia (*Bauhinia variegata*) grows in the Antilles

* From an abstract, in the *Jour. Soc. Chem. Ind.*, July, of a prize essay.

and Central America; its wood and bark contain tannin.—Leguminosæ.

Bearberry (*Arbutus Uva-ursi*, Linn.) grows in France, Italy, Spain, and Russia, and contains 14 per cent. of tannin in its leaves, according to some authorities, and 36·4 per cent. according to others.—Ericaceæ.

Oak (*Quercus*).—There are seventy to eighty species of oak, comprising 275 varieties, about half of which inhabit the old world and half the new world. The hard oak dominates in Europe, and of its two varieties *Quercus pedunculata* and *Quercus sessiliflora*, the latter has the bark which is richer in quercitannic acid. Of other oaks the following are given: *Q. Tauza*, 8 per cent. of tannin in its bark; *Q. Cerris* (hairy cupped oak), 10 per cent. of tannin in bark; *Q. Ilex* (evergreen oak), 10 per cent. of tannin in bark; *Q. Suber* (cork oak), 10 per cent of tannin in bark; *Q. Ballota*, 10 per cent. of tannin in bark; *Q. mirbeki*, 12 per cent. of tannin in bark; *Q. coccifera* (kermes oak), 15 per cent. of tannin in bark; *Q. Ægilops* (valonia), 8 per cent. of tannin in bark; *Q. infectoria*; *Q. glomerata* (Russian oak). The above are African and European. Of American oaks may be mentioned: *Q. alba* (white oak), 7·85 per cent. of tannin in bark; *Q. tinctoria* (black oak), 6·47 per cent. of tannin in bark; *Q. rubra* (red oak), 5·55 per cent. of tannin in bark; *Q. coccinea* (scarlet oak), 7·78 per cent. of tannin in bark. It may be generally stated that oak bark contains from 7 to 18 per cent. of quercitannic acid, while the wood and leaves contain 5-7 per cent.—Cupuliferæ.

Chestnut (*Castanea vesca*), abundant in Southern Europe and North America; the wood contains 68 per cent. of water when felled, 43 per cent. three months after felling, the bark being left on, and 35 per cent. five months after sawing and stripping. The wood and bark contain 4 to 12 per cent. of tannin (castanea tannic acid).—Cupuliferæ.

Cornelian cherry (*Cornus mascula*, dogwood) grows in Europe, especially France; its bark, leaves, and fruit contain 19·9 per cent. of tannin, according to Gassincourt, and 8-0 per cent. in the bark according to some other analysts.—Cornaceæ.

Carob (*Ceratonia Siliqua*, Linn.) grows in Spain, Italy, France, Algiers, and Egypt. Its fruit (St. John's bread) contains 50-55 per cent. of tannin.—Leguminosæ.

Carob of Judea (*Pistacea Terebinthus*, Linn.) grows in the Levant, and gives rise to horn-shaped galls which contain 25 per cent. of tannin, and are called "caroubes."—Anacardiaceæ.

Conocarpus arborea and *C. racemosa*.—West Indies and Brazil; its bark and fruit contain tannin. Its indigenous name is "mangle."—Combretaceæ.

Catechu.—The brownish-red catechu of Bengal is the exudation from the *Acacia Catechu* (Leguminosæ). The Bombay brown catechu is from the *Areca Catechu* (Palmeæ)—the areca palm. Gambier is the extract from the leaves of *Uncaria Gambier* (Rubiaceæ). To Bengal catechu have been ascribed of tannin 54·5 per cent. (Davy), 38·2 per cent. (Renard), and 48 per cent. (Villon). To Bombay catechu, 48·5 per cent. (Davy), 54·5 per cent. (Renard), and 55 per cent. (Villon). To gambier, 58 per cent. (Davy), 38-40 per cent. (Renard), and 65·79 per cent. (Villon). Catechuitannic acid (mimotannic acid) colors iron salts green.

Canaigre (*Rumex hymenosepalum*, Linn.) grows wild in the marshy lands of the southeast of the United States; its bulbs contain 20-24 per cent. of tannin. Most other varieties of rumex also contain tannin.—Polygonaceæ.

Paraguay acacia (*Curupay*) of South America contains 16-20 per cent. of "curupatannic acid."—Leguminosæ.

Divi-divi (*Cæsalpinia Coriaria*), chiefly from Mexico and Venezuela, contains ellagitannic acid to the extent of 30-45 per cent.; it imparts a reddish-brown color to leather.—Leguminosæ.

Eucalyptus (*Eucalyptus resinifera*) is used in New Caledonia, where it grows, as a tanning agent; the tannin in its leaves is estimated at 10-12 per cent.—Leguminosæ.

Fustic, young (*Rhus cotinus*, Linn.), grows in Southern Europe, and contains a tannin which colors iron salts olive green.—Terebinthaceæ.

Spiræa (*S. Filipendula*, Linn.) has astringent flowers and roots.—Rosaceæ.

Strawberry (*Fragaria vesca*, Linn.) The flowers and roots are astringent.—Rosaceæ.

Pomegranate (*Punica Granatum*). The bark of this tree was used by the ancients as a tanning agent under the name "malicorium." Davy attributes 18·8 per cent. of tannin to it. The shell of the fruit contains 22-25 per cent. of tannin, and is used for tanning in Japan; the wild pomegranate contains 46 per cent. of tannin.—Granateæ.

"*Gonakie*" (*Acacia Adansonii*), or red gum, yields very tanniferous fruit, which is used as a tannage in West Africa.—Leguminosæ.

Kino is the dried exudation or extract of several plants of which the principal are: *Dipterocarpus erinaceus* (Africa), *Butea frondosa* and *B. superba* (N. India), *Pterocarpus Marsupium* (India), *Coccoloba uvifera* (Jamaica), and *Rhizophora Mangle* or mangrove (Mexico), whose leaves contain 18-20 per cent. of tannin; the first four are of the Leguminosæ. Kino contains 40-55 per cent. of "coccotannic acid."

Mastic (*Pistacia Lentiscus*, Linn.). The leaves and bark contain 10-12 per cent. of tannin; used for tanning buffalo skins in certain countries.—Terebinthaceæ.

Mimosa.—The *Mimoseæ* include a great many varieties of acacia; the most valuable bark is from Tasmania; the Australian produce contains 25 per cent. (*A. cyanophylla*)—45 per cent. (*A. pycnantha*) of tannin; *A. sentis* (6·32 per cent.) and *A. binervata* (30·40 per cent.) are from New South Wales.

Myrobalans, the fruits of several species of *Terminalia* (Combretaceæ); their contents of tannin are variously given, 18·2 per cent. and 52 per cent. being the extremes; Loewe asserts the invariable presence of ellagic acid ($C_{14}H_{10}O_{10}$).

Galls are classified as European and Asiatic; of the latter there are Levant galls and Aleppo galls. The Levant galls contain 77·42 per cent. of gallotannic acid (Muller); the Aleppo galls contain 60-66 per cent. (Fehling). Villon gives the following for Aleppo and Levant galls: Black, 37-41 per cent.; green, 53-60 per cent.; white, 50-65 per cent. For Smyrna galls he gives: Black, 33-37 per cent.; green, 53-60 per cent.; white, 60-63 per cent. Renard gives 33-60 per cent. as a mean of all three kinds. Mierzinsky gives 60-66 per cent. as a mean. Of European galls those of Morea and Istria are the best, and have some 40 per cent. of gallotannic acid; Italian and Hungarian galls follow, and those of Germany and France are least important. French galls contain 9-10 per cent. of tannin; German galls, according to Villon, contain 18-19 per cent. of soluble and 13-14 per cent. of insoluble tannin. Chinese and Japanese galls are from plants belonging to the Terebinthaceæ, viz., *Rhus semialata* in China and *Distilium racemosum* in Japan; 69 per cent. is the mean of the many versions which have been given of the tannin in Chinese galls. Hungarian galls or "knoppern" are from oaks, and contain 20 to 35 per cent. of tannin. Bassorah galls are from an oak and contain 57 per cent. of gallotannic acid according to Kathreiner, Eitner, and others. Renard gives 27 per cent. and Villon 30 per cent., of which 3 per cent. is difficultly soluble. Bokhara galls are from the Indian tamarisk (Terebinthaceæ); their percentage of tannin has been variously given from 26 per cent. to 50 per cent.

Osier (*Salix viminalis*) contains 7-10 per cent. of tannin in its bark, which is largely used in Northern Russia.—Salicaceæ.

Quebracho comes from nearly all the eastern states of South America (source of aspido-spermine); red quebracho (*Loxopterygium Lorentzii*) contains 16-22 per cent. of "aspido-spertannic acid," while white quebracho (*Aspidosperma Quebracho*) only contains 10-11 per cent. At the Paris Exhibition of 1867 leather tanned with quebracho was shown for the first time in Europe, and in 1874-75 the utility of this wood became recognized in France. In whatever form quebracho wood is to be used, exposure to air should be avoided as much as possible; a sample which had a titre of 20 per cent. of tannin when freshly cut was found to contain only 16 per cent. after six months' storage.

Red rhatany (*Krameria triandra*, Polygalaceæ) grows in Argentina, Brazil, Chili, and Alsace; its bark contains "rhatania-tannic acid." The dried extract is with difficulty distinguished from kino; the bark, however, contains 42·5 per cent. of tannin, while kino averages 50 per cent.

Pine.—The bark of *Pinus Picea* (Linn.) contains 6-7 per cent. of a variety of pitannic acid. *Pinus canadensis* (Linn.) is the hemlock (white spruce) so much used as tannage in the United States; the bark contains 8-10 per cent. of tannin. The bark of *Pinus abies* (Linn.) contains 7-8 per cent. of tannin. Villon found 25 per cent. of tannin in the inner bark of *Pinus Aleppensis*, 3 or 4 per cent. in the outer bark and 7 per cent. in the cones.

Larch (*Larix europæa*) bark contains 1·66 per cent. of tannin according to Davy, and 5·8 per cent. in spring time according to Muller. There is no tannin in the wood of any of the Coniferæ.

Sumac is from several species of *rhus*, of which *Rhus coriaria* is the chief. The percentage of tannin in various sumacs is from 10-28·2 per cent.

Tormentilla reptans and *T. erecta* (Rosaceæ), wild in the Alps and Pyrenees, are employed as tannage in the Faroe Islands, where they produce a red leather. They contain tannin in the flowers and roots to the extent of 31 per cent. according to Renard ("tormentillo-tannic acid") and of 17 per cent. according to others.

Willow.—The various species of *Salix* (Salicaceæ) contain tannin in the bark and leaves; in the former it varies greatly, 1·4 per cent. and 16 per cent. having been found in different instances. Willow bark has long been used by tanners in Russia.

Mountain ash (*Pyrus aucuparia*, Rosaceæ) contains 5-7 per cent. of tannin in its bark, 3·5 per cent. in its wood, and some also in its leaves and fruit.

Valonia, *Quercus Ægilops* (Cupuliferæ). These well known acorn cups contain from 25 to 45 per cent. of tannin. The main varieties are *Chamada*, 33·4 per cent., *Chamadina*, 35·4 per cent. and upward, *Rabdista*, 30 per cent., and *Chondra*, 27 per cent. Powdered valonia is poorer in tannin than the cups, because before grinding the bark and wood chips are not completely separated.

A CHINESE PEACH.

IN the autumn of 1879 Dr. Bretschneider, the distinguished botanist and Chinese scholar, and at that time an attaché of the Russian Legation at Pekin, sent to the Arnold Arboretum the seeds of a number of trees and shrubs gathered on the mountains near the Chinese capital. Among them was a package of peach stones labeled "Cultivated Peach, growing wild."

These seeds, planted in the following January, produced vigorous plants, which began to flower in 1886, and have flowered profusely ever since. The flowers are large and dark-colored, but not larger, or of a deeper shade, than those of many cultivated peach trees. The fruit is free-stoned, rather thick-skinned, with white, juicy flesh; it has a fair flavor and good size, as is shown in the illustration, from a drawing made in the Arboretum by Mr. Faxon. The fruit, however, is not remarkable in quality, although rather better than the average, nor is it remarkable in size, and the only peculiarity of this variety which deserves attention is its great vigor and hardiness. The flower buds of the peach tree are often killed in this latitude; and in eastern New England the peach crop is very uncertain, the trees rarely producing more than one crop of fruit in four or five years. But up to the present time the flower buds of this Chinese variety have never been known to suffer, and year after year the branches are covered with flowers and abundant crops of fruit. Here, then, perhaps, is a variety from which seedlings can be raised which will be as hardy as the parent, and which, by careful selection, will produce in time fruit of first rate quality, or which can be used by the hybridizer to give vigor and hardiness to a new race of exceptionally hardy peaches. The quality of the fruit is already good enough to justify the effort to improve it; and the trees in the Arboretum offer to pomologists of cold climates the opportunity to extend northward the territory in which the peach can be successfully and profitably grown.

CHINESE PEACH.

This Pekin variety is of interest, too, as a probably direct Chinese descendant of the wild peach, which is now believed to have come originally from northern China, whence it was early transported by the way of India into Persia and other countries of the Orient, and then into Europe and North America.—*C. S. S.* in *Garden and Forest*.

THE BROOM AND ITS ALLIES.

"BROOM" is the name commonly given in this country to Cytisus scoparius, which certainly may lay claim to being considered one of the most beautiful of our native shrubs. Beesom, bisom, bizzom, brum and genest are given, as well as other names, in Britten and Holland's "Dictionary of English Plant Names," but not one, except that used at the commencement of these notes, has anything but a limited and local application. Plants belonging to other genera are also called broom; for example, the yellow Spanish broom (Spartium junceum), but these are ignored in the present paper, which is restricted to those members of the genus Cytisus which are in cultivation in this country, and which are worth a place in the garden or pleasure ground. The greenhouse kinds of Cytisus are also passed over.

The genus occurs throughout the greater part of Europe, Western Asia, North Africa, and the Canary Islands. According to Bentham and Hooker, it comprises some thirty-eight species, all of which are shrubs mostly with yellow flowers; a few have white flowers and still fewer purple. An attempt is here made to reduce the garden synonymy of many of the species to something like order, and this has only been possible by a careful study of a large series of differently named plants grown under similar conditions. Loudon, in his "Encyclopedia of the Trees and Shrubs of Great Britain," published fifty years ago, wrote as follows:

The species recorded in books are numerous, but if they were all brought together and cultivated in the same garden, we question much if a tithe of them would be found specifically distinct.

The laburnums were formerly classed under Cytisus; they now constitute a genus apart. The Dalmatian laburnum (called Cytisus Weldeni by Loudon and others) now forms another genus, and its correct name is Petteria ramentacea.

Cytisus scoparius has deep golden yellow flowers, larger than those of any other species in the genus. If it were rare and difficult to grow, one can imagine what a sensation it would create as a garden plant. Many an ugly, barren spot might be made beautiful by sowing broom seeds upon it, and in dry, gravelly places probably finer effects may be produced, at next to no trouble and cost, by the broom than by any other shrub cultivated in the British Islands.

Though it is at present comparatively neglected, yet in former times it was one of very great importance in rural and domestic economy. The branches are eaten by sheep and cattle, and on poor, gravelly soils formed before the general improvement of grass lands which has taken place within the last century the principal herbage. One of the principal modern uses of the broom, both in Britain and on the Continent, is to form brooms or beesoms, for which purpose, as the specific name would imply, it appears to have been used from time immemorial. The young shoots were formerly used as a substitute for hops in brewing beer, and the flower buds, just before they became yellow, were pickled in the manner of capers (Loudon).

The roasted seeds have been proposed as a substitute for coffee. In southeastern France and in parts of southern Europe a fiber obtained from the twigs was formerly much used in the manufacture of cloth and cordage; but the increase of railways and the facilities for obtaining more abundant and cheaper materials made from cotton and hemp have all but caused that particular industry to become extinct.

Now and then, although a native plant, the broom suffers during winters of exceptional severity, probably to a greater extent in rich garden ground than in poor soils, where the growth would be less vigorous. In a paper read in 1882 by Colonel H. M. Drummond Hay at a meeting of the Dundee Horticultural Association, the following interesting remarks occur:

The common broom also, which one would suppose to be hardy, was in many places, both on the low grounds and on the hills in my neighborhood (Seggieden, Perthshire), almost entirely killed during the winter of 1880–1881, while the white broom (Cytisus albus), a native of Portugal, remained uninjured.

The following names of Cytisus scoparius occur in gardening books: Genesta scoparia, Sarothamnus vulgaris and Spartium scoparium.

C. scoparius var. Andreanus differs from the type in the rich coloring of the keels, *i. e.*, the lower petals. It has been stated in some gardening publications that the seeds of this come true, but all the seedlings I have yet seen have proved when in flower to be undistinguishable from the common wild plant; the seeds, too, from which the Kew batch of seedlings was raised were ripened on pot plants, which flowered under glass long before any broom was to be found in blossom in the open air; under these circumstances cross fertilization with the type could not possibly take place. C. Andreanus was discovered growing wild in Normandy in 1886, by Mons. Edouard Andre, the famous landscape gardener, and a colored plate appeared during that year in the *Revue Horticole*, under the name of Genista Andreana.

No more charming plant for the decoration of the greenhouse or conservatory has come under the notice of the gardening public for many years, and as its propagation and cultivation are so simple, it is certain to become a general favorite. All the plants first distributed were grafted on laburnum stocks.

For quick work and flowering in March this is quite allowable, as treated thus, larger, denser heads, and consequently a greater profusion of flowers, are obtained in a shorter time than when the plants are grown from cuttings. Where, however, a group is required to occupy a permanent position the specimens should be on their own roots, as the laburnum stock soon outgrows the scion and the plants cannot be long lived when grafted on stocks so different in habit and structure from the common broom.

C. scoparius var. albus has flowers of a very pale yellow. Flowering twigs of this pretty variety were exhibited at the meeting of the Royal Horticultural Society on June 10, 1890, by Mrs. Robb, of Liphook, who has proposed for it the approprite name of moonlight broom.

C. s. var. pendulus is a dwarf form with very large golden yellow flowers, and of prostrate or pendulus habit; it is a suitable plant for rockwork or similar positions where the taller growing types would be out of place. In some catalogues this occurs under the name of Cytisus prostratus, an appellation which rightly belongs to a widely different plant.

C. s. Flore-Pleno is mentioned by Loudon. This I have never seen; perhaps it is now lost to cultivation.

C. albus (the White Spanish broom) is a native of Spain and Portugal, and flowers in May. It is of very rapid growth; in three or four years from seed it often makes bushes 5 ft. or 6 ft. or more in height and as much through; when covered with its white blossoms there are few more beautiful objects in the garden. This species has a number of synonyms; among them are Cytisus multiflorus albus, Genista multiflora, Sarothamnus albus, Sarothamnus parviflorus, Spartium album and Spartium multiflorum. The variety incarnatus when in full flower is hardly distinct from the type, but earlier is conspicuous by the reddish purple tinge of the unopened buds.

C. Ardoini is a native of the Maritime Alps; it occurs on the hills near Mentone at elevations of from 3,500 ft. to 4,000 ft. It is a dwarf shrub of prostrate habit, barely exceeding 3 in. in height, and bears a profusion of deep golden yellow flowers in April and May. It makes a charming rock plant.

C. austriacus, an Eastern European species, makes a compact leafy bush about 2 ft. in height; the yellow flowers are borne from July to September in terminal clusters. This passes under the names of C. banaticus and C. serotinus (the plant to which this last name rightly belongs is a mere form of the next mentioned species). C. austriacus var. leucanthus is a variety with flowers of a paler yellow than the type. C. Rocheli is a synonym.

C. biflorus, a native of Eastern Europe, is a neat growing bush from 2 ft. to 4 ft. in height; the yellow flowers appear in May, and are borne generally in twos, sometimes in threes or fours, in the axils of the leaves almost the whole length of the long twigs. It is perfectly hardy, and is a good plant for the shrubbery border. Among some of the many garden synonyms of this species are the follwoing: C. canariensis, C. caucasicus, C. elongatus, C. leucanthus (the true C. leucanthus is a form of the preceding species), C. medicaginoids, C. ratisbonensis, C. ruthenicus, C. serotinus, C. supinus, C. euralensis.

C. capitatus is widely distributed throughout Central and Southern Europe; it is a compact habited shrub with leafy branches bearing in July and onward clusters of yellow flowers at their tips, and attains a height of 2 ft. A year or two ago this species—grafted on tall stems of laburnum—was sold by some nurserymen as Cytisus nigricans nanus; I have also seen it named C. calycinus.

C. decumbens, a native of Eastern Europe, is a dwarf prostrate species with large pale yellow flowers, and is a pretty and desirable rockery plant. It is by no means common in cultivation. This species has also been described under the names of Genista Halleri and G. prostrata. As stated under Cytisus scoparius pendulus, the latter synonym is sometimes wrongly used for that plant.

C. hirsutus, from Southern and Eastern Europe and Asia Minor, is a dwarf yellow flowered shrub 1 ft. to 2 ft. high, and blooms in June and July. It is suitable for the front of the shrubbery border, or for making a low mass in an open, sunny spot. Some of the names under which I have seen this in gardens and nurseries are C. falcatus, C. polytrichus, C. Tournefortianus, C. triflorus, C. uralensis.

C. linifolius, a native of southwestern Europe, is very distinct in aspect from all the species already mentioned; it is an upright growing shrub a few feet high, with rosemary-like leaves, and yellow flowers which are produced in early summer. It is the least hardy of the kinds mentioned in these notes, all the rest, with the exception of C. monspessulanus, which with C. linifolius would do in the south and west of England, being probably as hardy as our common broom. C. linifolius makes a pretty bush, and where it does well is sure to be admired. It is found in books under the following names: Genista linifolia, Spartium linifolium, and Teline linifolia.

C. monspessulanus, sometimes known as Madeira broom, is a native of the Mediterranean region. It is a very quick growing, yellow flowered species and blossoms in May. Some of its garden synonyms are Genista candicans, Teline candicans, Genista triangularis, and G. triquetra; these last two names rightly belong to a very different plant.

C. nigricans, one of the handsomest species in the genus, has long terminal erect racemes of yellow flowers which are freely produced in July and August; under favorable conditions it makes a beautiful bush 6 ft. in height. The specific name was given to it by Linnæus on account of the plant turning black when dried. In a wild state it is widely distributed in Eastern Europe. In some catalogues—mostly foreign ones—it is named Lembotropis nigricans.

C. præcox much resembles the white Spanish broom in habit. It is a hybrid between that plant and the following species (C. purgans). It bears a profusion of cream-colored flowers in early summer, and is one of the most easily grown and most ornamental of hardy shrubs. When seeds of this are raised, very few of the plants prove like the parent; the vast majority resemble closely the white Spanish broom. Cuttings, however, are easily struck, and it is desirable to keep up a stock by this means, as old specimens which have outgrown their position or have become unsightly from any cause do not bear severe pruning. Young ones do better in every way.

C. purgans makes a low bush not more than 2 ft. or 3 ft. in height, and produces an abundance of golden yellow blossoms in April and May. In habit it somewhat resembles C. albus, but the branches are shorter and more rigid in old plants. It is a native of central and southern France and Spain. Other names under which this species is known are Genista purgans, G. spartioides, Sarothamnus purgans, Spartium purgans and Spartocytisus purgans.

C. purpureus.—This is usually found in nurseries grafted on tall stems of laburnum. It makes an ornamental specimen so treated, but it is generally not long lived. On its own roots it makes a beautiful procumbent rockery or border plant, and bears a profusion of purple flowers from May to July. There are also varieties with white and rose-tinted flowers. C. purpureus is a native of Eastern Europe, and, according to Loudon, was introduced to British gardens just a century ago.

The so-called purple laburnum (L. Adami) is a graft hybrid between Cytisus purpureus and Laburnum alpinum, the so-called Scotch laburnum.

C. sessilifolius, a native of Southern Europe, is a charming shrub with small, glossy green, almost stalkless leaves and short, erect, terminal racemes of yellow flowers. It is of upright habit and attains a height of from 4 ft. to 7 ft. It is also known under the names of Cytisus quinquefolius and Lembotropis sessilifolius.—*N., in The Garden.*

CYTISUS PURPUREUS ALBUS.

ANTARCTIC EXPLORATION.

By EUGENE MURRAY AARON, Ph.D.

PERHAPS nothing is more surprising to the student of geography or the lover of exploration than to examine the card catalogue of some great library and make comparison of the references having to do with Arctic and with Antarctic exploration. On the one hand a vast array of volumes and a still greater wealth of literature in periodical form attests the absorbing interest that has for many decades been felt by scientists and travelers in researches toward our North Pole. On the other hand, the very meager number of reference

cards illustrates how very little of a speculative nature has been written of our South Pole, and how much less of actual research there has been to bring before an eager public. Why this is so it would be hard to explain. That there are excellent and substantial reasons impelling to such exploration, both scientific and commercial, long known to those versed in the subject, there is no manner of doubt. Nothing, at this time when exploration in *terræ incognitæ* is well nigh impossible, could bring greater renown in the opinion of all civilization than such an expedition, if well planned and thoroughly executed, would bring to those conducting it. And when it is considered that the climate in the Antarctic region is undoubtedly much less severe than that appertaining to the Arctic,* and that much more that is new and of interest to science is bound to be unearthed in the little known region, it is more than surprising that such almost foolhardy experiments as that of the Peary expedition continue to be fitted out and to call for funds and governmental aid, while almost the entire inner Antarctic region remains a geographical blank. This being so, it is much to be regretted that the expedition, so favorably considered by scientists and explorers alike, which has but recently been abandoned in Australia, could not have been fitted out and sent forth on the generous lines mapped out for it. If the English, with their wealth of scientific ability and their shipping resources, cannot afford to send out such an expedition, it would at first seem as though no other power could afford to consider the matter. Yet it is quite safe to predict that the time is near at hand when some other power, attracted by the chances of commercial gains and the credit due to such exploration, will send forth an exploring party. It would seem that the United States, anxious to do all in its power to attract the attention of Latin-American trade interests, and well able to furnish both the brains and the sinews for such an expedition, could hardly afford to neglect such a chance as now presents itself. But it is not likely that we will avail ourselves of the opportunity, so long as the present "cheese-paring policy" continues to rule Congress in all things having to do with governmental scientific research. It is a great pity that the authorities in control of the World's Fair project at Chicago could not have been prevailed upon to undertake such an exploration, for the results thereof could not have failed to yield a much more generous return for the outlay than have been brought in by most of the expenditures of that organization in search of the striking and *bizarre*, though less permanently valuable or educative.

When taking our maps for purposes of comparison, we realize that the region in question contains over 8,000,000 square miles—an area quite twice in extent that of Europe; and when we consider that this region is surrounded by physical conditions so peculiar as to promise peculiar correlated conditions within its vast area, we can see that in questions of geography alone there is much of value to be derived from a painstaking examination of the region. Yet, as has well been said, "the expected additions to the geography of the region are, of all the knowledge that is to be sought for there, the least valuable. Where so many of the physical features of the country—the hills, the valleys, and the drainage lines—have been buried beneath the snow of ages, a naked outline, a bare skeleton of a map, is the utmost that can be delineated."† Yet so excessively limited is our present knowledge of the geography of the region that anything to be discovered in this realm of research will have its value and should by no means be neglected. Ross merely viewed the coast of this great area at Victoria Land, between 163° E. and 160° W. longitude. Only on two occasions was he on its barren shore, and then but for a few moments. From 97° E. to 167° E. Admiral Wilkes followed the uncertain shore line, and described, as he believed, a range of mountains in the interior; he, however, landed nowhere on the shore. Yet where Wilkes told the cartographers to place his coast range of mountains, Ross coming after hove his lead in 600 fathoms of water. Since then the Challenger expedition has thrown further discredit on the findings of Wilkes by meeting with unbroken seas where he placed a well-defined coast. Yet, with a conservatism rarely equaled even in science, our photographs continue to issue maps with the coast line of Wilkes as set forth in his account of his voyage. A shore line of varying prominence has since been discovered by D'Urville extending for about 300 miles between 136° to 142° E. longitude; and between 45° and 60° E. are to be found Enderby's and Kemp's lands. Just south of Cape Horn, also, land has been discovered trending from 45° to 75° S. latitude. These few disconnected bits of coast line are all that we now have of a geographically accurate knowledge of the region; far less in extent are they than one fourth of the coast which we have good reason to infer must there await discovery. Are these detached portions parts of an insular system hidden beneath a load of snow and ice, or are they parts of a continent? This is the chief geographical question awaiting determination. Both Ross and Sir Wyville Thompson inclined to the view that this region was occupied by an ice-hidden archipelago, and the former believed that a wide channel would be discovered between North Cape and the Bellaney Islands running toward the pole.‡ Careful observations of the local currents would do much to set this question at rest; several such with very marked power are noted by Ross in his log.

Nowhere else on this globe do fire and frost so divide the sway and war with each other in an attempt to gain possession of the region. Erebus vomiting forth lava and ashes upon the vast expanse of snow and ice which surrounded and coated much of it is one of the unsurpassed sights of which Ross tells us. As is well known, volcanoes are the product of a progressive upbuilding, and not of elevation or erosion, as is the case with other mountains. How would this sort of periodical growth combine or clash with the periodic falls of snow? Volcanic ash is one of the most effective nonconductors of heat known; a layer of it but a few inches thick spread over the snow would enable the molten lava following it to flow over the snow without

* See Maury's Meteorology, p. 466.

† "The Objects of Antarctic Exploration." G. S. Griffiths. Before the Bankers' Institute of Australia, August 27, 1890.

‡ Ross, Voyage, p. 1221.

melting it. Incredible as it seems, Lyell tells us that in 1828 he discovered a glacier sealed up under a crust of lava on the side of Etna. Only by the non-conducting powers of the ash was it possible for the ice of the glacier thus to remain unmelted while the molten mass of the lava was cooling and thus almost hermetically protecting it. The center of the south polar ice cap has been variously estimated at from 3 to 10 miles deep. This crushing weight must cause a continued spreading out of the semi-viscous mass; a movement which is thought by Griffiths to "thrust the ice cliffs off the land at the rate of a quarter of a mile per annum." Yet it is probable, as pointed out by Taber,* that a large part of the coast line cannot be extended seaward, on account of the great depth of the ocean bordering its shores. It is only where shoal seas border the Antarctic coasts that any considerable increase can take place. In this problem the intercalation of rigid layers of lava with the viscous ice must be something of a factor; but it is a factor whose influence is yet but merely guessed at. Whether this growing mass from the falls of snow and ash and lava tends to compact and then spread out or, on the other hand, to pile up, or, still again, to shrink by melting, notwithstanding the preservative effects of the lava coatings, is a most interesting problem only to be solved by actual examination. And nowhere else can this examination be so well pursued as here.

It is hardly necessary to point out how important it is from the geological point of view that a determination shall be had as to the nature of the rocks upon which this mighty mass of later deposition rests. Whether they are sedimentary in their nature, or are plutonic, is a matter of much importance in determining the age and nature of the continental existence of this area in geologic times. The dragnets of the Erebus and the Challenger have already brought up fragments of both sorts of rock formation from the icy depths bordering this region; so it is most probable that such formations will be found beneath the ice fields. In fossil-bearing beds, too, there is reason to hope that such a tour of research would be repaid by laying bare such material as would enable geologists to test the value of the theory that this is a land submerged after the close of the Mesozoic. As portions of Victoria Land were recorded by McCormack (Ross' Voyage) as free from snow, it is likely that such investigations could be conducted with comparative ease, and that even a flora of limited extent would there be disclosed. And, finally, in addition to these geological goals, whenever the snow will permit, all considerable elevations should be carefully searched for basaltic dikes, that nickel and specular iron in the mass may be found if present. At Ovifak, in North Greenland, Baron Nordenskiold found such masses of unoxidized metal, unknown elsewhere on the earth, as were very close in their resemblance to the visitants, of nonterrestrial origin, called meteorites. There is no reason known to us why these should be peculiar to any given area, and if they be discovered in the Antarctic regions, speculation as to their origin would be given a fresh impulse.

Climatic conditions also afford no unimportant field for discovery and research in this region. That the North Polar regions have more than once been blessed with a temperate climate is now certain. Within that circle occur Paleozoic coal, Jurassic fossil-bearing strata, and Eocene beds laden with a wealth of fossil vegetation, in no inconsiderable quantity. So, as regards the Antarctic circle, "competent biologists," to again quote Griffiths, "who have examined the floras and faunas of South Africa and Australia, of New Zealand, South America, and the isolated islets of the Southern Ocean, find features which absolutely involve the existence of an extensive Antarctic land—a land which must have been clothed with a varied vegetation, and have been alive with beasts, birds, and insects. As it also had its fresh water fishes, it must have had its rivers flowing and not frost-bound, and in those circumstances we again see indications of a modified Antarctic climate." Even now it is safe to presume that the average of climate is milder around the South than near the North Pole. Maury maintains that the saturated winds drawn up to great heights within the Antarctic circle and eased of their moisture must thus disengage a great amount of latent heat; and, as more heat must thus be liberated in South than in North Polar regions, he infers that a relative difference greater than that between the Canadian and English winter will be the result in favor of the Southern area.† That this is by no means the tempestuous zone that is to be found immediately north of it, can easily be judged from such meager records as have thus far been had of the region. In Ross' log the reader constantly comes on such comments as the following: "Beautifully clear weather;" "Land seen 130 miles distant;" "Atmosphere so extraordinarily clear that Mount Herschel, distant 90 miles, looked only 30 miles distant." So, too, McCormack, on the Erebus, after three years of voyaging, and having bid farewell to the Antarctic regions, remarks: "It is a curious thing that we have always met with the finest weather within the Antarctic circle; clear, cloudless sky, bright sun, light wind, and a long swell."‡ Familiar only with the fog and gloom of the Arctic summer,§ it is easy to see how seamen and explorers have become prejudiced against the open season around the South Pole. But whatever may be the meteorological conditions of the region, they must exert a very considerable influence on other climates to the north of them, and hence a closer acquaintance therewith cannot but be of the utmost value to those students of meteorology who are slowly and with infinite pains extracting order from the present chaotic state of that science.

Very naturally it is the physicist who looks to research in this region with the greatest interest, while such questions as have to do with pendulum observations, the earth's magnetism, and the phenomena of auroral displays are still unsolved. As is well known, the pendulum makes about 240 more vibrations per day in the Arctic region than at the Equator, thus showing greater intensity in the force of gravity in the

* "Causes which Produce Cold and Mild Periods." By C. A. M. Taber. *Science*, Vol. XIX., p. 359, 1892.

† Maury's "Meteorology," p. 466.

‡ McCormack, "Antarctic Voyage," Vol. 1, p. 345.

§ Scoresby, "Arctic Regions," pp. 97 and 137.

northern area. But, whether this results from the earth's oblateness or from the presence of the dense masses of ultra-basic rocks, referred to above, is yet a question in dispute. Whether the earth's figure is as perceptibly flattened at the South as at the North Pole, and other important data on which to work would thus be among the interesting results for which the physicist would impatiently wait.

Again questions having to do with the mean or permanent distribution of the world's magnetism are such as call for long-continued and painstaking observation within the South Polar region. Coincident and concerted observations there made with others at the main observatories of Europe and America could not fail to throw much light upon a series of problems as yet in darkness, but of the greatest importance to the student of electrical phenomena. In a recent report to the British Association, Captain Creak uses these words: "Great advantage to the science of terrestrial magnetism would be derived from a new magnetic survey of the southern hemisphere, extending from the parallel of 40° south as far toward the geographical pole as possible;" and Griffiths remarks that "the present exact position of the principal south magnetic pole has also to be fixed, and data to be obtained from which to calculate the rate of changes in the future."

Closely interrelated to the questions of terrestrial magnetism are those of the phenomena of auroral display. The nature of auroras is very obscure, and it is only recently that any considerable advance has been made in the formulation of the laws which govern them. Dr. Tromholt, who has for long made the auroral movements a subject of close observation, tells us that "the aurora borealis, with its crown of many lights, encircles the pole obliquely, and that it has its lower edge suspended above the earth at a height of from 50 to 100 miles, the mean of 18 trigonometrical measurements, taken with a base line of 50 miles, being 75 miles. The aurora forms a ring round the pole which changes its latitude four times a year. At the equinoxes it attains its greatest distance from the pole, and at midsummer and midwinter it approaches it most closely, and it has a zone of maximum intensity which is placed obliquely between the parallels of 60° and 70° north.

"The length of its meridional excursion varies from year to year, decreasing and increasing through tolerably regular periods, and reaching a maximum about every eleven years, when, also, its appearance simultaneously attains its greatest brilliancy. Again, it has its regular yearly and daily movements or periods. At the winter solstice it reaches its maximum annual intensity, and it has its daily maximum at from 8 P. M. to 2 A. M., according to the latitude." [Griffiths.] But, while these observations, very complete for the northern hemisphere, are of much value, it remains to be seen how closely they agree with the phenomena of the aurora australis. With a shallower and moister atmosphere in the latter region, it is more than probable that marked modifications would be revealed by systematic observations there. And, while these were being made it is more than likely that some light would be shed on the mooted point as to how much influence auroral displays have on the weather, if at all. That there is a close interrelation between auroral excitation and the electric currents is well known. "The current that reveals itself in fire in the higher regions of the atmosphere is precisely the same current that plagues the operator in his office," it has been well said. But where the maximum auroral intensity displays itself in high latitudes there must await the observer facts regarding this interdependence that are yet undreamed of.

To the zoologist and the botanist there is less of interest, undoubtedly, in this region than is usually revealed by explorations into the warmer regions where yet there remains for them a small and ever-decreasing *terra incognita*. Yet even here, in the bleak southernmost ices, there cannot fail to be a considerable mass of material awaiting the enthusiastic collector. Wallace, both in his *Distribution of Animals* and in his *Island Life*, calls attention to the similarity of forms existing in the faunas of South America and Australia and New Zealand; and Hutton, in his *Origin of the New Zealand Flora and Fauna*, states that 44 per cent. of the latter's flora is of Antarctic origin. Such widely removed lands as the Auckland, Campbell, Macquarie, Kerguelen, Crozets, and the Marion Islands, with Tristan d'Acunha, Tasmania, Patagonia, South Australia, the Falklands, and South Africa, have both a plant and animal life which is related in no inconsiderable degree.

Commenting on this, Wallace very pertinently says: "The heat-loving reptilia afford hardly any indications of close affinity between these regions, while the cold-enduring amphibia and fresh water fishes offer them in abundance.* What can be plainer than that these widely removed regions must in ages past have been either parts of one continent or members of an intricate and extensive archipelago? Where, now, can we better look for further botanic and zoologic light on this question than in the region now under discussion?

To the student of evolution it is apparent that from the Mesozoic forms of animal life, as we now know them from fossils derived from temperate and tropic zones, could not be derived such higher placental mammals as appear abruptly with the dawn of the Tertiary period. The opponents of the theory of evolution have always been most prompt and gleeful in their inquiries after the "connecting links" which, it must be admitted, ought to be found somewhere in considerable quantities in the fossil state. Huxley's "Lemuria," a vast continent, long lost beneath the waters of the Pacific, the original "Eden" of many latter day ethnologists, may be the region whose subsidence has buried its much sought for treasures beneath fathoms of waters, but, however that may be, the discovery of new forms of animal and plant life and the discovery of fossil remains, as already pointed out, cannot fail to shed a flood of light upon this, one of the most engrossing problems in the study of geographical distribution as it affects organic evolution. In fact, already is enough known of the material derivable from the Antarctic region to warrant Mr. Blanford, in a recent address before the Geological Society of London, in stating that "a growing acquaintance

* Wallace, *Distribution of Animals*, p. 1400.

with the biology of the world leads naturalists to a belief that the placental mammalia and other higher forms of terrestrial life originated during the Mesozoic period still further to the southward—that is to say, in the lost Antarctic continent." Having quoted him thus, Griffiths adds that "it almost necessarily follows that wherever the mammalia were developed there also man had his birthplace, and if these speculations should prove to have been well founded, we may have to shift the location of the Garden of Eden from the northern to the southern hemisphere." What a vista of results, even to the production of fossiled primitive man and his immediate predecessors and the harmonizing of the thus corrected geological account with the Mosaic cosmogony, would open up, it may be left to the imagination of the reader to conjecture.

Finally, the commercial side of such a quest could not fail to be productive of much of interest to those to whom the foregoing claims are of but doubtful validity. Ross and his followers tell us that the whale of commerce was seen by them in Antarctic waters, beyond any doubt. Large, tame, and to be caught in great numbers they tell us they were. As is known to all, the whale of commerce is becoming very scarce in Arctic waters, and the price of whalebone has gradually risen year by year, until it now exceeds the large sum of $10,000 a ton, or over 30 cents per ounce at wholesale. Captains John and David Gray, of Peterhead, Scotland, men known throughout the whaling trade as most successful masters in this branch of maritime commerce, in a pamphlet issued by them on this subject, say: "We think it is established beyond doubt that whales of a species similar to the 'right' or 'Greenland' whale, found high in northern latitudes, exist in great numbers in the Antarctic seas, and that the establishment of a whale fishery within that area would be attended with successful and profitable results." According to the *Proceedings of the Royal Geographical Society*, these eminent authorities on this subject are even now engaged in fitting out a couple of vessels for an experimental voyage into this region, with the search for the right whale as the prime object.

From a statement issued by them the following words are taken: "We have been induced to select that region in the Antarctic area lying between the meridian of Greenwich and 90° west longitude as the locality in which, in our opinion, the fishery we have projected might be prosecuted with the greatest advantage. . . . It is accessible from Great Britain by a direct route lying between the continents of America and Africa, not exceeding 7,200 miles in length, or a two months' passage, at an average speed of five knots per hour. . . . We should recommend that, in the event of vessels being fitted out to prosecute the fishery in the South polar seas, they should leave this country [Scotland] in August and reach the whaling ground by the end of October, which would give at least four months, viz., November, December, January, and February [the Antarctic summer]—ample time for completing their cargoes, and enabling them to reach Britain again in May." This is but one item of commercial advantage to be derived from an exploration within the Antarctic circle; the mineral or chemical values to be extracted therefrom I can best leave to conjecture. But the whale industry offers a quite sufficient bait to the *qui bono* impulses of the average utilitarian who votes the money necessary for a government exploration; the wealth of scientific data can be allowed to remain as a secondary consideration, though no doubt a score of discoveries would be made that would make such an expedition ever memorable in the annals of material advancement.

DARJEELING.

By C. JACOBUS, M.D.

DARJEELING is the most oddly situated and most curiously built of any "summer resort" I have seen on any of the five continents I have visited.

It is located on the summit and sides of a hog-back spur which runs out northward from the first high eastern and western range of the Himalayas. The spur is four miles long, and curves around like a cow's horn toward the west. It is 7,886 feet high at its southern end, where it starts off from the long east and west range we had to climb and cross to reach the station, and 6,874 at the northwest end at the limit of the town. This spur on its eastern side slants down abruptly, at an angle steeper than 45°, to the Rangmu River, 5,000 feet below, and on the western, or inner side of the curve, it goes down at a more gentle slope 4,500 feet to the Little Rangit River, crossing which, and climbing 8,000 feet on the opposite hill, you come to the boundary of Nipál, only ten miles from Darjeeling as a crow would fly. From the outer point of the cow's horn to the northward, the slope of the land is more gentle, running down six miles to the Great Rangit, which, bringing down the waters, all summer long, from the melting of the Great Snowy Range, is the boundary between British territory and the native kingdom of Sikkim, and which cuts through the heart of the Himalayas at a level of only 800 feet above tide water. All these slopes and lateral spurs are covered with some of the richest tea plantations in the world.

This hog-back Darjeeling spur is so sharp and rocky that only here and there, except at the southern end, has it been leveled off enough to place a house thereon. Most of the houses are built in niches cut in the more or less steep slopes. The eastern slope is so steep and almost precipitous, for the first two miles, that scarcely a house has been glued into its sides; but from thence it becomes less steep, and many houses are built and are building. Just under the central part of the station three stone houses are now building in niches cut in the rocky side, one above another, and so steep is it that, though the houses are not more than forty feet apart horizontally, the foundation of one is many feet above the tops of the chimneys of the two-story house next to it. They look out due east over the mountains of Bhútan, but have also a view of the eastern end of the towering snowy range that divides Sikkim from Tibet. The broader end of the ridge, where it starts out from Senchal Mountain at the south, has been partially leveled off by government, and a military depot has been established as a sanitarium for ailing officers and men of the British regiments in India. The artillery barracks occupy the southern and highest part—7,800 feet above the sea. Then come the officers' houses and the infantry barracks, with a small parade ground leveled off on the widest part. These together reach more than a mile. Then the hog's back slopes down to 7,000 feet at the center of the station, and rises again to Observatory Point, just beyond which is "The Shrubbery," as the park and house of the Governor of Bengal is called, and, after passing next the house of the Rajah of Cooch Behar, we come upon half a mile of beautiful native forest, reserved for a recreation ground for the people, called Birch Hill Park. Footpaths and bridle paths have been made through it, and on the summit of a little hillock a tiny lawn has been made with settees about, and a nice pavilion erected for people to sit in and look out upon eighty miles of everlasting snows.

It is upon the inner and less steep slope of the horn that most of the residences and the government offices and stores and banks and places of business have been built, and below these the market, bazars and native town are nestled in a pretty nook, with the Himalayan railway station just at the end of the chief bazar street, at an elevation of only 6,820 feet; and below this again are the Botanical Gardens, with fine specimens of both tropical and arctic vegetation, the former being mostly under glass.

The inner slope of the horn is indeed less steep than the outer, and yet it is sufficiently steep to make extensive excavation necessary to secure a perch for a good-sized house. I have yet to see a quarter of an acre of level land that was not made so by man. At the center and most thickly built part of the station it is specially difficult. The villas and houses on the upper side of the main street must be approached by high stairs or steep zigzags. Those built on the lower side are entered from the street into the upper story. The finest new house built last season is on the lower side of this main road. It has a beautiful three story and basement front looking out toward Nipál and Mt. Everest; but its chief entrance, its "front door" and main hall, is from main street into the rear of the third story! Or rather the lower stories front to the west and the third story to the east. The house in which I reside is at the rear only six feet from an almost perpendicular bank reaching up seventy feet, and with only twelve feet of front dooryard there is a steep slope down 150 feet on to the roof of our nearest neighbor below us.

There are no carriage roads and not a carriage in Darjeeling. Good bridle paths indeed there are, running along each side of the crest of the spur. Of those on the inside of the curve the highest runs from one to two hundred feet below the southern part of the crest. A second runs some two hundred feet below that, and is six miles long, reaching from Birch Hill to Ghûm. It is the most nearly level of all and wide enough for two horses to canter abreast all the way, and with a parapet on the lower side. Two hundred feet below this again is the only cart road on these hills. It was built forty years ago, all the way up from the plains to bring the heavy traffic from Calcutta and the Ganges steamers, long before the day of railways in this region. It was skillfully engineered, thoroughly built and well macadamized by government at an enormous outlay, being broad and with a stone parapet all along its lower side to keep fractious bullocks from rushing or tipping their carts over the sides, to roll down the steeps a thousand or two thousand feet into the gulches up the sides of which the road climbs.

When the Darjeeling Himalayan railway was projected, government gave the company the right to lay their tracks on the surface of this road, keeping as much at one side as possible, and for the most of the way they utilized it. Numerous houses have been erected along this last cart road, for six miles, both below and above. Below this again are other bridle paths, and scores of zigzags running to the multitudinous tea estates all down the slopes for 5,000 feet.

The chief mode of locomotion here is horseback, on the sturdy, sure footed Bhútia, Tibetan, and Sikkim ponies, found here in large numbers, and to be had on hire for $1.00 per day, or $20 per month with saddle and a groom in attendance who will run with you his twenty miles a day and take all care of the horse. I said the chief mode here was horseback. I am mistaken. The chief mode is on foot. Excepting invalids, everybody walks; ladies, gentlemen, children. The invigorating air invites pedestrianism. Ladies start out for a five or seven miles walk, including two or three thousand feet of climbing, as there is only one level road, and come back the rosier and fresher for it. I find that I have myself, though coming up far from strong, already walked 448 miles, or from five to fifteen miles a day, including many times three to five thousand feet of climbing in a single walk.

Next to horseback riding comes the "dandy." A dandy, here, is not a "dude," but a kind of reclining chair, with a hood like a carriage top, to raise when it rains, and borne by three of the strong Bhútia (Bhootanese) coolies, two behind and one in front. These go along with a swinging pace between a walk and a horse's trot in rapidity, and will take even a heavy person right up from the bottom of the town to the top, two miles, and 1,000 feet, without stopping.

Then comes the jinriksha. That is usually supposed to be a Japanese invention. For it is not generally known, though true, that it was invented and first made and introduced into Japan, and thence to all the Orient, by an American Baptist missionary in Yokohama, less than thirty years since. It soon took the place of the Japanese "kango," a basket hung on a pole, in which one sits and is borne on the shoulders of two men, and in which I was myself carried over two mountain ranges in the interior of Japan some years ago, and then was drawn in a jinriksha by two coolies forty miles in the next seven hours. From Japan it soon crossed into China, taking the place of Sedan chairs, where there were roads: for I was myself drawn in jinrikshas in the ports, though carried in a Sedan chair in the roadless interior. It came on to Singapore and then to India, and is driving out palanquins, dhoolies, tonjons, munchiels, and even dandies. On all the bridle roads jinrikshas, drawn by two or three Bhútia coolies, work well; but many of the zigzags leading up and down to the residences have stone steps, or are too steep for any vehicle except the dandy; so that its days are not yet quite numbered.

The climate of Darjeeling is simply delightful, when not too rainy. My self-registering thermometer, hung under the awning outside of my window, looking northwest, through May, and so far through June, has shown for the whole period a maximum of 69° and a minimum of 52°. It has varied only 17° in two months, never once coming up to what is marked as "summer" heat at home. I have never been in a place with so little variation. It stands through each night at from 53° to 57° and through each day from 57° to 67°, or very rarely 69°. I sleep with the window open, two blankets being always enough, and never too much, as the nights do not vary. The temperature of Darjeeling for the year is only 2° above that of London. London's mean temperature is 50° and that of Darjeeling 52°. Darjeeling is never cold like London in the winter; it is never hot like London in the summer.

Darjeeling was a part of the Himalayan kingdom of Sikkim until 1835. In 1827 Captain Lloyd and Mr. I. W. Grant were deputed by the India government, by request of those kingdoms, to arbitrate in a boundary dispute between Nipál and Sikkim. They then saw the Darjeeling range and were so captivated by it that they strongly advised the government of India to endeavor to acquire it for a sanitarium. The home authorities, after considering the matter until 1834, authorized Major Lloyd to treat with the Rajah of Sikkim for its acquisition, who in February, 1835, signed a deed of gift, which I have seen, conveying the Darjeeling spur with some ten miles width of territory to the British power for a sanitarium. In 1838, Dr. Campbell, who had been some years in Nipál in government service and knew the hill people, was sent as commissioner to Darjeeling to open it up. He built roads, felled forests, erected the first barracks for the military sanitarium, and threw the newly acquired land open for settlement. The superb climate attracted many people.

In 1850, in reprisal for outrageous conduct on the part of the Sikkim authorities, in imprisoning and subjecting to various indignities and maltreatment two English officers who were botanizing and exploring in Sikkim, with the Rajah's written authorization, all the Sikkim Rajah's territory lying south of the Great Rangit River from Nipál on the west to the river Teesta on the east, which was the boundary of the native kingdom of Bûhtan, a region some thirty miles wide and forty to fifty miles long, down to the plains of Bengal, was seized and annexed to Darjeeling. This constitutes the present District of Darjeeling, which now is entirely given up, so far as the land is suitable, to tea plantations, some of the finest in the world, of which I may speak more particularly in another article.

Darjeeling is chiefly known to the world, however, as one of the finest sanitaria in all India, the most easily approached, having a railroad to its very summit, and the one nearest to the mysterious sanctuary of "The Abode of Snow."

But oh! the clouds and rain! During these months the normal state is rain or dense cloud. Clouds come up in martial array over the Ghum Saddle, and, surrounding the city, penetrate every street and enter every door, and, anon, as quickly disappear. Clouds gather suddenly in the deep valleys below us, before our very eyes, and galloping up at more than cavalry speed, swoop down on us all, and we are prisoners. Clouds instantaneously form right around us, because a whiff of air, as an orderly, has come from the snows; clouds so dense that you have to look at your watch and compass to see in what part of the heavens the sun is.

"The City in the Clouds" is, indeed, its appropriate name for many months in the year. And rain! During June, July and August eighty inches fall; nearly an inch a day. It sometimes rains twenty-four hours in a day for days together. It has seemed to do so for the last fortnight, but now a break appears to have come in the rains; and the clouds, too, will sometimes suddenly and absolutely disappear in one quarter of the heavens, revealing rapturous visions of the snows, and gather again as swiftly. Just now this house seems to be an island in a sea of cloud. No other object in the universe is, at this instant, visible to us, although it is bright midday, for the cloud is white and radiant. As I wrote the preceding page a break to the north occurred, and the silvery snows of Kunchin Junga were seen glistening down in dazzling brilliancy 20,000 feet above my head. In half an hour I may again, from my window where I sit, see the most glorious, enrapturing sight in the world. Eighty miles of everlasting snows! But of these I must write in my next.—*The Independent.*

RECENT DISCOVERIES OF MANGANESE ORE.

AT the last meeting of the North of England Institute of Mining and Mechanical Engineers, Mr. Edward Halse communicated two papers describing new finds of manganese ore, one at Mulege, in Lower California, and the other at Arenig, Merionethshire, Wales.

Mulege is on the western shore of the Gulf of California. Several outcrops of manganese ore veins are found crossing the trachyte, which forms the bulk of the rock. The veins consist of psilomelane and gypsum, and they vary in thickness from a few inches to three or four feet. The prevalent direction is about northwest to southeast. The chief veins run in wavy lines, consisting of a succession of curves, each a few feet long. The best ore is found at La Trinidad, where two veins intersect. No distinct evidence of true fissure veins is to be obtained anywhere, but the ore occurs in superficial vein-like fissures and rock joints. It seems probable that the manganese ore has come from the trachyte or by leaching and subsequent deposition.

In the Lower Silurian formation, in Eastern Merionethshire, Wales, there are deposits of trappean ash and feldspathic porphyry, accompanied with manganese ore. This ore consists chiefly of psilomelane, and also as pyrolusite, and it occurs in much the same manner as in the find mentioned in Lower California. In one of the hills which consists of upper trappean ash, with a mass of feldspathic porphyry cropping out of the northern side, several vein-like deposits of manganese and iron ores were found. Samples of this ore gave the following analysis:

Manganese, 46 per cent.; silica, 14 per cent.; phosphorus, 0·147 per cent., and iron, 1·7 per cent. In one vein the ore was 21 in. thick, and was separated from a

9 in. vein by 11 ft. of moderately soft rock. And this vein, 3 ft. wide, was discovered, consisting of impure earth, brown oxide of iron, and patches of pyrolusite and psilomelane. How far the manganese penetrates in lateral and downward direction, has not yet been ascertained. At the present price of manganese, however, it does not pay to extract the ore, or to pursue investigations as to the extent of its occurrence.

CARRIAGE WITH ELASTIC TRACTION AND SUSPENSION.

To diminish the fatigue of the horse, while at the same time preserving for the traveler the undoubted advantages of an eminently elastic suspension, and to constitute under a very light form a carriage with a strong brake presenting absolute guarantees of stability—such is the interesting problem that Mr. Lemoine, the well-known inventor of the brake that bears his name, proposed to himself.

The inventive mind of this skillful investigator was not caught at fault, and we publish herewith the happy solution that he has found. The characteristic principle of his invention consists in the special mounting of the body upon four long suspensions which support it beneath the axle. As this arrangement permits of the oscillation of the body in all directions, it diminishes shocks and renders the vehicle very agreeable to its occupants. Fig. 1 gives the details of the suspension. An elliptic spring, *e e*, is fixed upon each of the extremities of the axle, *b*, in the ordinary manner by means of coupling plates, *f f*.

Beneath the axle, which is curved, is placed the frame, *a*, that carries the body of the vehicle. Two long branches, *g g*, at once elastic and jointed at their extremities, connect the frame, *a*, with the elliptic springs, *e e*. These joints of the supports, *g*, and their flexibility give the frame the facility of oscillating in all directions. It is well, however, to guide and reduce lateral oscillation.

To this effect, the frame, *a*, rests by its interior face upon a spring, *h*, having the form of an inverted U with unequal branches. The small branch is fixed to the axle, while the long one is guided by a slide, *i*, connected with the frame of the vehicle, whose lateral motions are thus limited.

At the moment of starting, the horse exerts a stress transmitted by the thills to the frame, which displaces itself in space, while the axle remains immovable until the tension of the suspension springs is sufficient to cause the revolution of the wheels; consequently, from the oscillation, the body moves before the wheels, and at the beginning of the rolling the axle is situated back of its normal position with respect to the body.

The charge upon the axle is thus less. Starting is rendered easier, not only by reason of such diminution of the load, but also by reason of the progressive motion thus realized. The relatively large mass of the body and its load of passengers, displaced in the first place under the stress of traction, communicates a part of its live force to the axle and facilitates the starting. The vehicle is provided with the Lemoine brake, which acts in a manner contrary to that of the usual type, in which the block is pressed against the wheel. In the new carriage, it is the wheel, *c*, on the contrary, which, moving with the axle, is applied against the block, *k*, which is fixed upon the sides, *l*, of the body. This results naturally from the oscillation of the body. Whenever speed is slackened or there is a sudden stoppage, the center of gravity of the body displaces itself automatically. The result is that a charge proportional to the resistance occasioned by the brake is carried back of the axle and prevents the bearing-down effect upon the horse of the prejudicial component spoken of above. The brake, in its application to this system of carriage, therefore plays the part of a compensator. The same phenomenon takes place also in a descent. The effort of the horse to hold back displaces the body toward the rear with respect to the axle, and the load upon the bolster is consequently lightened.

The arrangement of the brake is as follows: The fixed point of attachment of the brake cable, *m*, is at *n*. Traction is effected by acting upon the pedal, *o*, and is communicated through a rod, *p*, and a guide pulley, *q*, to the extremity of the brake cable. The winding of the cable causes the wheel to advance against the brake block, while the body is carried backward. The stoppage is instantaneous and cannot affect the horse.

We have in our various figures represented the principal positions of the vehicle. In the position of rest upon a level (Fig. 2), the axle is naturally in coincidence with the median plane of the body. It is sensibly the same during a normal movement upon a horizontal surface. The body balances itself lightly upon its suspension, the oscillations having, to the right and left of the axle, an amplitude proportionate to the extent of the joltings.

The same is not the case at the moment of starting (Fig. 3). The pull given by the horse in the first place displaces the body in the direction of the motion. The wheels, remaining behind, will be carried along only in the second phase of the motion, as has been stated above.

Fig. 4 represents the position of stoppage upon a sloping road. During the slowing up that precedes the stoppage the backing stress exerted by the horse causes the median plane of the body to pass to the rear of the axis of the wheels. This displacement of the load progressively diminishes the stress upon the bolster up to the moment at which the block fixed to the front of the body bears against the wheels and arrests their motion. An identical displacement of the body with respect to the wheels is brought about by the use of the winding brake mounted upon the vehicle. It will be seen, then, that during a descent, as well as in a sudden stoppage, every stress abnormal for the horse is avoided.

The curved arrangement of the axle has the advantage of notably lowering the center of gravity of the load, and of rendering the carriage incapable of being overturned.

The model shown in Figs. 2, 3, and 4 has a seating capacity for fourteen persons. The vehicle has four entrances, two on each side, and, by reason of its slight elevation above the ground, access to it is very easy.

It realizes by its numerous qualities the type of the

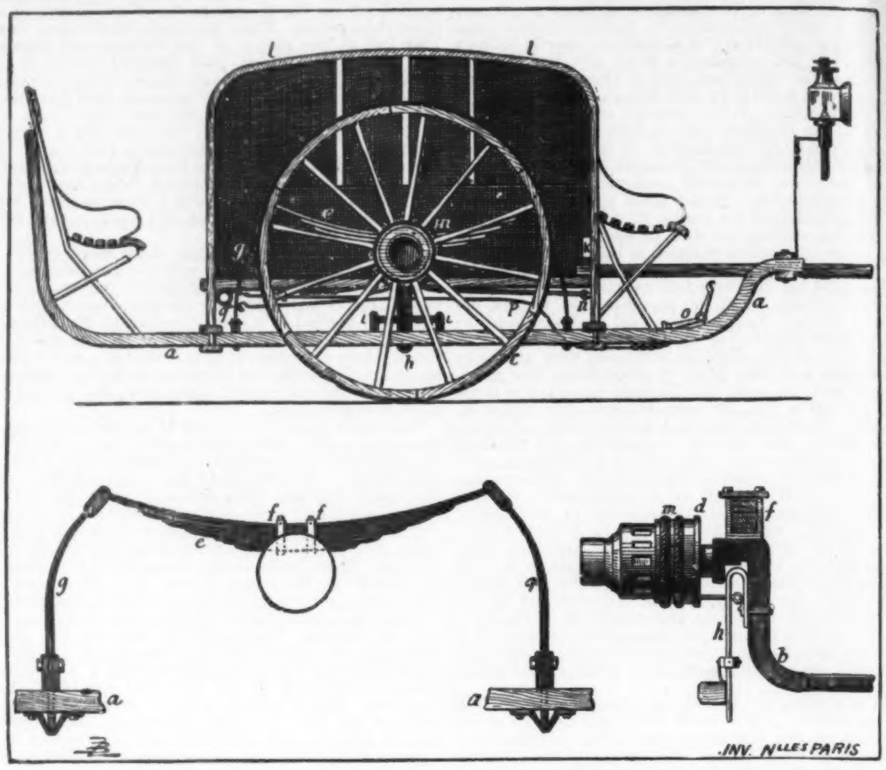


Fig. 1.—DETAILS OF CONSTRUCTION OF LEMOINE'S NEW VEHICLE.

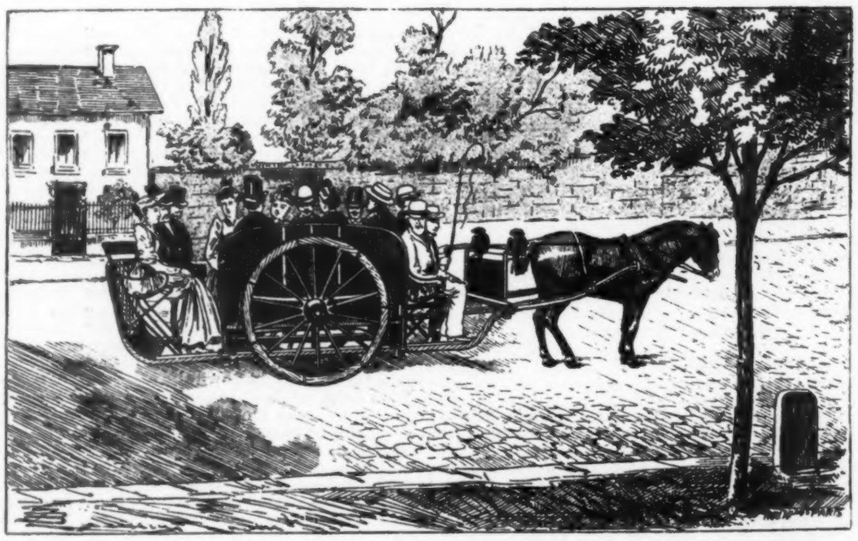


Fig. 2.—CARRIAGE AT REST UPON A LEVEL.

Fig. 3.—CARRIAGE AT THE MOMENT OF STARTING.

family carriage and the ideal for country driving. It is, in fact, very light, and this advantage, combined with the diminution of the work of traction, permits of the use of one horse for the carriage of fourteen persons. Its elastic suspension suppresses jolting and gives an agreeable swing, while the happy grouping of the passengers, most of whom face each other, contributes, by facilitating conversation, to the adding of a new charm to the pleasure of the drive.

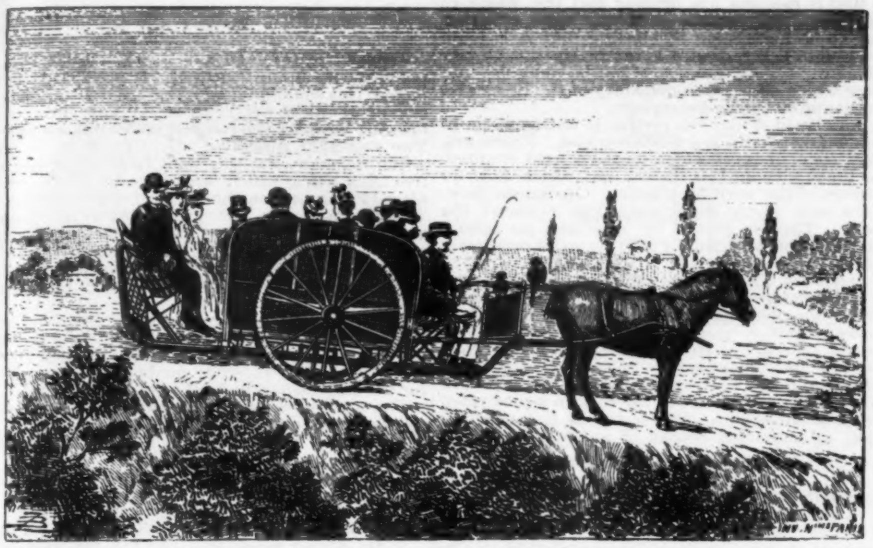


FIG. 4.—CARRIAGE AT REST UPON A SLOPE.

Another consideration, which is of importance, is the low price of the vehicle, which the simplicity of its parts permits of constructing at small expense.—*Les Inventions Nouvelles.*

DUPLEX HORIZONTAL BORING MACHINE.

THE machine shown in the engraving below is designed for boring two cylinders simultaneously, the boring table having a self-acting traverse along the bed by means of a powerful screw, with variable feed motion, driven from the fixed headstock. The spindles are of ample dimensions, with large bearing surfaces, and the worm wheels upon them, together with the feed motion mentioned above, insure an excellent finish in the work produced. The machine illustrated is capable of boring cylinders up to 24 inches diameter by 54 inches long. The makers are the Northern Engineering Company, limited, Halifax.—*Industries.*

WHAT IS THE BEST PREPARATION TO USE ON A PAINTED WALL THAT IS TO BE PAPERED?

AT the recent meeting of the New Jersey Association of Master Painters and Decorators, at Long Branch, a discussion of this subject took place.

Mr. Barbier.—To open the discussion on this subject I would state that in my experience I have found brown sugar or molasses mixed in a proportion of about two pounds of brown sugar to one-third of a pail of water and used as a size is very good. I have heard discussions by paperhangers on this subject, and the trouble that they have experienced in papering on painted walls, and they have used glue size without effect. I have used this on papered walls and varnished walls with great success.

The old method for preparing varnished walls used to be to kill the varnish with pearlash and then with glue size, but you will find that by using the sugar size right over a varnished or painted wall you will have no trouble in getting the paper to stick to the surface.

Mr. Brazo.—In this part of the State paperhangers use vinegar, and they get good results from it.

Mr. Test.—We use vinegar exclusively without anything else. When you come to a whitewashed wall I think that vinegar is better than anything else; sometimes I add a little glue. I think it is better than some other mixtures on the market, although I make it a point to try everything that comes out.

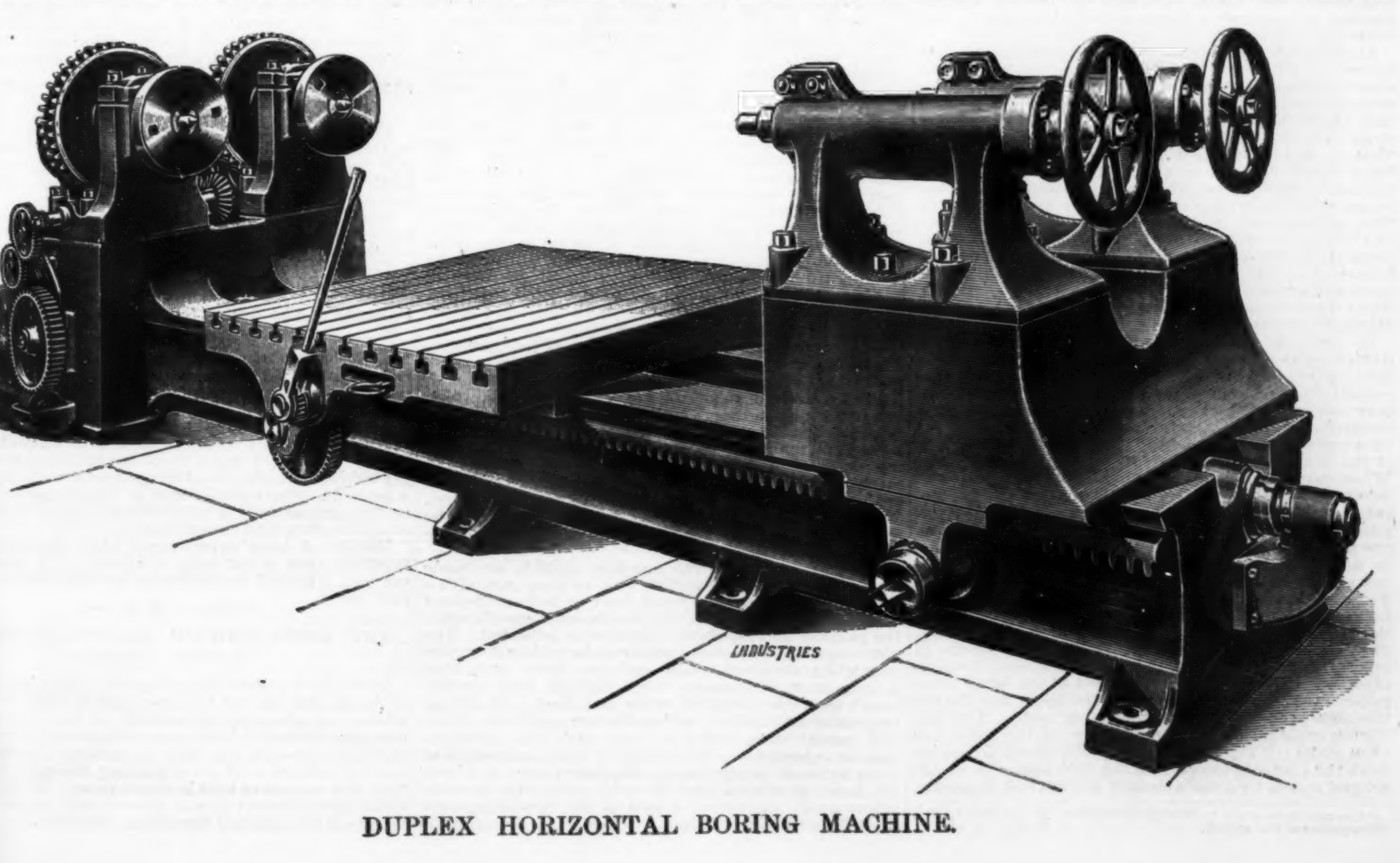
Mr. Barbier.—On the coast we have the greatest difficulty with varnished walls, and the walls sometimes become much coated with an efflorescence, which must be overcome, and the only way I have found to do that is to first coat the wall with some alkali, as pearlash, and then take coarse brown sugar and one gallon of vinegar, or acetic acid, to a pound of the same. After this use glue on the walls, and as before stated, it never dries properly and then rolls down and makes little lumps. I have done this for eleven years, and used nothing else, and have never had a failure by using that method.

While talking about papering walls I think it will be well to give an experience we had this spring, so that if any other members of the association have the same experience they may be able to profit by it. Our firm has the contract to paper four houses that were finished up with a skim coating, hard finish. We sized them and in the course of time the walls were dry, and they stood about ten days before we proceeded to paper. We noticed in some of the rooms that the size was not cracking, but peeling off. You could take and peel the size off in ribbons. By putting it in the mouth we found the gluten absent. We resized and papered thirteen rooms. We had one man at the work and the rooms were quite large. There was an interval of five days and on Saturday everything seemed to be all right, but on Monday when we came there we found the paper in four of the rooms hanging loose from the walls. On rubbing the walls with the hand, we found it was like putting it in a plaster of Paris barrel. We did not know what to think; we had never had such an experience before on the same kind of a wall. We proceeded with three other rooms to wash the size off, and we cut it with vinegar. We then made a size with molasses and glue, and sized the wall and even put some molasses in the paste, and then in twenty-four hours the paper in two of the rooms dropped off. We called on the architects, and said something was wrong with the plaster. They looked the matter up and found that three other paperhangers in the city had had the same trouble. We found one who had undertaken to paper three houses, and had made three attempts and gave up, and lost three hundred and seventy-two dollars, and we found that the same plasterer had done those houses. We found in another case that another paperhanger had had trouble, and thus we came across another case where a man who thought he knew it all took the contract to make the paper stick, and he had the pleasure of papering four rooms out of six, and he told me he did not know whether it would stick or not. The result of all this was that it developed that the mason was in the habit of using the same plaster that was used for the center pieces. The plasterer had used one barrel where he should have used four to the mixture, and there was a great deal of cream of tartar in the plaster. The result was that we had to paint the walls, then size them, then paper them, and I noticed that the plaster and lime were so overlaid even before we commenced to paper that it had commenced to affect the paint. The result of our protest was that the mason had to pay the damage, which cost him $125.

It is pretty well understood in Jersey City that the trouble is at times with somebody else besides the paperhanger. These three men had lost money simply because they did not get together and ask why such and such a thing happened. Fortunately the mason had not received his money for the work. There is no rule for telling these walls that I know of. One thing we noticed about the walls before sizing them, there was an efflorescence that could be brushed off, and three or four hours afterward it came back again. There is not a closet in the house you can hang up a coat in without the white coming off; so if you ever come across that you will know where the blame is. It is only possible to fix it by using a filler, or by painting and then sizing it.—*Painting and Decorating.*

THE MINING INDUSTRIES OF HUELVA.

THE British vice-consul at Huelva, in his trade report for the past year, says that the great strides in prosperity made by the province of Huelva during the last twenty-five years are due to the scientific development of its enormous mineral wealth. It is not, however, the first time that that mining district has been the scene of great activity, for the large masses of ore in its mountains furnished quantities of highly prized metals to the old nations of the Mediterranean. According to history and tradition, the Phenicians were the first known people to work the Huelva mines, remains of their workings, ovens, coins, and other articles having been found in most of the mines. After the Phenicians came the Romans, and during their dominion in Spain mining operations were greatly extended, as is proved by the great amount of scoriæ to be found in every mine. This is calculated to be in all 20,000,000 to 25,000,000 tons, showing that immense quantities of ores must have been extracted during the centuries of Phenician and Roman work, until it ceased with the invasion of the Vandals. It is not apparent that either the Goths or Moors worked the



DUPLEX HORIZONTAL BORING MACHINE.

Huelva mines, so that they have practically been idle for fourteen centuries, for the little that was done during the last and the first half of this century can hardly be taken into account. The great first impulse was given by the foundation, between 1866 and 1875, of large foreign companies.

The mines began to be thoroughly opened out, railways were constructed to the Port of Huelva, and magnificent shipping piers were built in the river. Other companies then followed, and a period of great activity set in, completely altering the aspect of the province and of the port.

The copper pyrites, or cupreous sulphur ore, composed of about 48 per cent. sulphur, 44 per cent. iron, and 3 per cent. copper, is the principal ore mined in the district, and contributes very considerably to the copper production of the world. By far the greater part is sent to Great Britain, although large quantities are sent to Holland and Germany; France and the United States are also consumers, and a small quantity goes to Denmark. British vessels convey nearly all the copper pyrites, but a good many cargoes have been shipped to Germany in German steamers. The pyrites sent to the United States is of the poorer class, containing about 1¼ per cent. of copper only on the average, and is shipped principally to Philadelphia and New York. The ore is also partly treated at Huelva by smelting, which produces the regulus, containing about 30 to 40 per cent. of copper, and by precipitation on to pig iron in large tanks, giving cascard or precipitate with 60 to 95 per cent. of copper, according to treatment. The iron pyrites is what is called pure—that is to say, it contains 44 per cent. of iron and 52 per cent. of sulphur, but no copper, and it is extracted from one mine only. Besides the considerable quantities shipped to Great Britain, there is a large consumption in France, Germany, and the United States. It is, as a rule, friable, and not hard and compact like copper pyrites. Manganese has been exported in larger quantities recently, but the low price still keeps a great many mines closed. It is very generally distributed over the mining district of the province, and is of a good quality. Neither quicksilver nor lead are products of Huelva, the former coming from the famous mines at Almaden and the latter from the Linares district. They are shipped direct to London.

DIMENSION STONE QUARRYING—THE BLASTING PROCESS.*

Quarrymen have, ever since the introduction of blasting, tried to direct the blast so as to save stock. Holes drilled by hand are seldom round. The shape of the bit and the irregular rotation while drilling usually produce a hole with a triangular section. It was observed many years ago that when a blast was fired in a hand-drilled hole, the rock usually broke in three directions radiating from the points of the triangle in the hole. This led quarrymen to look for a means by which the hole might be shaped in accordance with a prescribed direction of cleavage.

As the Portland quarries, in Connecticut, the oldest in the country, were carried to great depths the thickness of bed increased. With beds from 10 to 20 feet deep, all of solid and valuable brownstone, it became a matter of importance that some device should be applied which would shear the stone from its bed without loss of stock and without the necessity of making artificial beds at short distances. A system was adopted and used successfully for a number of years, which comprised the drilling of deep holes from 10 to 12 inches in diameter, and charging them with explosives placed in a lune-shaped canister made of two pieces of sheet tin, with sections, minor segments of a circle, soldered together and the ends filled with cloth or paper. Earth or sand was filled in around the canister in the drill hole, so the effects of the blasts were practically the same as though the hole was drilled in the shape of the canister. Straight and true breaks were made, although the system was expensive, as obviously a larger hole than necessary was drilled.

Another of the older systems of blasting is that known as lewising. Two or three holes are drilled close together on parallel, the partitions between being broken down. Thus a wide hole or groove is formed, into which the powder is charged by being rammed down or in a tin canister the shape of the trench hole. This system is confined almost entirely to granite. Then again there was the well known plug and feather system, in which the plugs were driven between the feathers by the blast and the rock split. This process frequently resulted in irregular breaks and damage at the top of the hole. During all these years there was conspicuous waste due to the lack of knowledge of the influence of the shape of a drill hole on the effect of a blast. The system devised by Mr. Knox does all and more than was claimed for the old Portland canister system.

In the first place, in this system a round hole is drilled by hand or otherwise, preferably by a machine drill, as it is important that the hole should indeed be round. In sandstone of medium hardness these holes may be situated 10, 12 or 15 feet apart. Then the holes should be reamed out with an instrument made for that purpose, at least one and a half times the diameter of the hole. This is done to the bottom of the hole. When finished the hole resembles the shape of the Portland canister. Then the hole is charged with the smallest possible amount of slow-acting powder; dynamite is unsuitable. The cap should be inserted near the bottom of the cartridge. Then the tamping is put in, not directly upon the charge, as in most systems, but an air space is left between. The tamping should be placed about 6 to 10 inches below the top of the hole, and placed securely, so it will not blow out. The intervening air space may be filled with a wad of hay, grass or paper. The hole is now ready to blast. If several holes are on a line, they should be blasted simultaneously by electricity. The effect of the blast is to make a vertical seam connecting the holes, and the entire mass is sheared several inches or more. The following explanation of the rationale of the blast has been given: "The gas acting equally in all directions from the center is forced into the two opposite wedge shaped spaces by a force equally prompt and energetic. All rocks possess the property of elasticity to greater or less degree, and this principle being excited to the point of rupture at the apices of the section of the hole, the gas enters the crack and the rock is split in a straight line, simply because, under the circumstances, it cannot split in any other way." The new form of hole is, therefore, almost identical in principle with the old Portland canister system, save that it has the great advantage of a shaped groove in the rock which serves as a starting point for the break.

It is also more economical than the Portland canister, in that it requires less drilling and the waste of stone is less. It is, therefore, not only more economical than any other system of blasting, but it is more certain, and in this respect it is vastly superior to any other blasting system, because stone is valuable, and anything which adds to the certainty of the break also adds to the profit of the quarryman.

The popular idea that the system is antagonistic to the channeling process is a mistaken one. There are, of course, some quarries which formerly used channeling machines without this system, but which now do a large part of the work by blasting. Instances, however, are rare where the system has replaced the channeler. The two go side by side, and an intelligent use of the new system in most quarries requires a channeling machine.

The first work done by this method was in 1885, and at the close of that year two quarries had adopted it. In 1886 it was used in twenty quarries, in 1887 in forty-four, in 1888 in upward of one hundred, and at the present time about three hundred quarries have adopted it. Its purpose is to release dimension stone from its place in the bed, by so directing an explosive force that it is made to cleave the rock in a prescribed line and without injury. The system is also used for breaking up detached blocks of stone into smaller sizes.

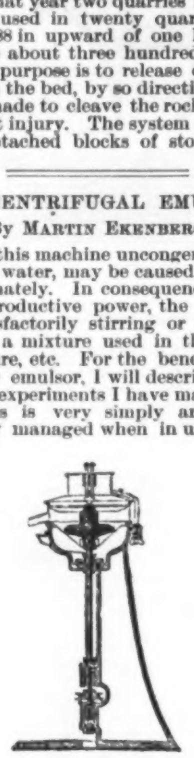
* Abstract from article by William L. Saunders, M. Am. Soc. C.E., in *Transactions* of that society.

THE CENTRIFUGAL EMULSOR.

By Martin Ekenberg.

By the aid of this machine uncongenial fluids, as for instance oil and water, may be caused to mix mechanically most intimately. In consequence of its continuous work and productive power, the emulsor substitutes most satisfactorily stirring or other means of bringing about a mixture used in the tar industry, soap manufacture, etc. For the benefit of those who do not know the emulsor, I will describe it before entering upon the experiments I have made with it.

The apparatus is very simply and substantially made, and easily managed when in use; it consists of



CENTRIFUGAL EMULSOR IN SECTION.

two massive plates, turned toward each other, and fastened upon a vertical axle (see figure). The plates rotate with a rapidity of 6,000 to 7,000 revolutions per minute. The opening between them may be increased or diminished from 0·05 mm. to 1—2 mm. By the size of this opening the grade of oil in the emulsion is regulated. If the opening be small, 0·05—0·01 mm., a very fine emulsion is produced—for instance, from olive oil and water. In this case the oil globules are much smaller than those in milk. From such an emulsion the fat is separated by gravity within 20 to 25 minutes, but if the water be alkaline, the emulsion remains for a longer period. A larger opening produces a less fine emulsion, which separates itself in much shorter time, say in 2 to 3 minutes, if the opening be 1 mm. The quantity produced is in proportion to the size of the opening, and varies from 300 to 2,000 liters per hour. Previous to the making of an emulsion all mechanically introduced hard and coarse particles which cannot pass through the opening must of course be separated by filtering. Emulsions containing as much as 40 per cent. of oil may be made, even up to 50 per cent. of certain oils. On the other hand, one may mix 5, 10, or even 30 per cent. of water with the oil; consequently there is a limit for the emulsive process in reference to the quantitative proportions of the mixtures. Emulsions of water in oil become valuable when small quantities of salts or other agents in solutions of water are desired to act on the oil. The consumption of agents may in this way be reduced to the smallest possible quantity. Emulsions of water or salt solutions in oil made by the emulsor have several interesting qualities, of which I hope to speak further in a future article. The emulsor may be used either in an ordinary separator frame with a pulley (see figure), or else in a steam turbine frame, the latter being the most handy, as the machine will work simply by turning a steam valve.

The plates of which the emulsor consists are made from strongly tinned Swedish iron, or from iron with a preparation of antimony and lead, or from acid-proof bronze: which material will be chosen depends upon the purpose for which the machine is intended. The plates may easily and inexpensively be replaced by new ones when worn out, which can only take place after a long and continuous use. Should they become rough from the action of acids, etc., they may simply be ground and tinned with antimony and lead, which will render them equal to new; and this operation may be repeated a great number of times on account of their extreme massiveness. Emulsor plates of Swedish iron are always used for acid emulsions in cases where small quantities of iron in the cleansing water do not harm the product. When used for alkaline emulsions and washings with water, the plates will prove to possess great durability.

All other parts, frame, etc., are equally solid and constructed on the same principles as the "Alpha" milk separators.

The following is a brief account of experiments made by me for the purpose of ascertaining the fitness of the machine for the object intended, namely, intimate mixing of uncongenial liquids. The experiments are made with quantities varying between 50 and 300 kilogrammes.

Series A.—*Washing away of Free Mineral Acids from Oils and Fat.*

From Olive Oil.—To common machine oil I added 5 per cent. of sulphuric acid of 1·50 specific gravity, and mixed this sour oil in water in such a way that emulsion of about 20 per cent. of oil was obtained. The opening between the emulsor plates was about 0·1 mm. The emulsion separated itself in 10 to 15 minutes. After one more washing with fresh water the oil was free from acids, which was tested with litmus paper, after having shaken the oil with warm distilled water. The oil was at first not clear, owing to the presence of air bubbles and drops of water, which all disappeared after the oil had stood for 24 hours undisturbed. One part of the oil was obtained free from water and air immediately, by filtering through newly burnt sulphate of lime.

The oil may be separated easily from the washing water with a receiver constructed on the principle of the Florentine flask, and capable of holding that quantity of emulsion which is made in the time required for the oil to separate itself from the emulsion.

The washing water contained in the above mentioned cases a small number of minute particles of oil; these could easily be collected in either of the following ways:

1. By filtering through cotton wool and boiling the wool in water, when the oil rises to the surface.
2. By leaving the washing water undisturbed for about 48 hours, when all the oil will float on the top.
3. By mixing more olive oil with the washing water and using a large opening. The large oil globules hereby produced brought the smaller ones with them to the surface and a clear washing water remained. This way of separating minute particles of oil from the washing water is very effective; even from alkaline washing water all oil could be reclaimed by using mineral oil.
4. By centrifugal power in continuous oil separator with the same rapidity as the emulsor.

As I have shown, there was no difficulty in extracting the whole of the oil from the emulsion.

At a repeated experiment with olive oil, when 5 per cent. of sulphuric acid of a specific gravity of 1·84 was used, all free sulphuric acid was washed away in two washings, one with warm and one with cold water. In this case, however, the oil was strongly affected by the acid.

From Tallow.—Raw tallow was melted and about three per cent. of nitric acid was mixed into this. After two washings with water I got a pure, light, acid-free product. When the tallow had separated itself from the emulsion all cell fragments, etc., stayed underneath the pure tallow as a well defined layer. This way of separating membranes, loosened by the action of the acid, seems to come in very handily for refining tallow.

From Mineral Oils.—In a lubricating oil of a brownish color I mixed 5 per cent. of sulphuric acid of 1·84 specific gravity. The oil was then washed twice with water; the first washing water had taken up much coloring water. After a third washing with concentrated solution of caustic soda, I got an oil which had only a slight yellowish tint.

In another experiment I took raw vaseline from Galicia, melted it, and with help of the emulsor I mixed into it about 5 per cent. concentrated sulphuric acid and some chromate of potassium, washed the vaseline with warm water, and then filtered it through a layer of bone black 10 cm. thick (to get rid of carbon particles and newly formed brown coloring matter), and by this process I got an almost colorless vaseline.

Series B.—*Washing away of Free Fatty Acids from Oils.*

From Olive Oil.—I mixed the oil with water containing 0·5 per cent. of caustic soda. The oil extracted from this emulsion was then washed in clean water and lastly in water with some sulphuric acid. After this process the oil was free from fatty acids.

Out of the first washing water, which contained soap, a liquid fat consisting principally of fatty acids separated itself when acid was added.

From Hemp Oil.—This oil was treated in the same way, and was also made perfectly free from fatty acids.

Series C.—*The Use of the Emulsor in Manufacturing Soap.*

a. Cocoanut Oil was mixed with a strong solution of caustic soda. This emulsion, already containing a great deal of fat in a saponified condition, yielded immediately on boiling a homogeneous soap.

b. Cocoanut Oil was warmed up to about 110° C. and then mixed with a solution of caustic soda at boiling point. The result was a liquid containing a number of gas bubbles, which caused an opalescence and hardened when cold. On examination it was found to contain no free fat, *so that a perfect and almost immediate saponification had been obtained.*

Results of later experiments with the emulsor in saponification of fat with sulphuric acid, washing of tar, etc., I intend to publish at an early date.—*Chemical News.*

THE ELECTROLYTIC MANUFACTURE OF WHITE LEAD.

The *Revue Industrielle* gives the following account of the process used at L'Usine Voad for obtaining lead white. In a solution of acetate of ammonium, lead bars are suspended with pieces of non-conducting substance at the cathodes, such as carbon. When a current of carbonic acid gas is passing through the solution, the acetate of lead is decomposed, the carbonate being precipitated; this is filtered and pressed. The filtrate is reconducted directly to the bath.

EASY LESSONS FOR STUDENTS.

ELECTRIC BELLS.

IF there is any one piece of electrical apparatus that the public is more familiar with than another, it is the electric bell. It is, without doubt, by far the most extensively used electrical instrument of all, and yet, notwithstanding this fact, remarkably few people have taken the pains to study its working. The only mysterious thing about the operation of an electric bell is the electricity that causes it to work; everything else about it and its accessories are simple enough for a child to understand.

The fact that there is something mysterious about

FIG. 1.—ELECTRIC BELL.

electricity need not, however, deter any one from studying its various applications. We know how to produce it and how to control it, so what we can make it do for us is that which now concerns us most.

Fig. 1 shows one form of an electric bell. There are many styles made, but they are all alike in essential features. They all possess electromagnets, gong, and hammer, and how these parts are assembled makes no great difference in the results.

The magnets and armature are of the ordinary form. At the back of the armature is placed a tongue-shaped spring with a contact point at one end which opens and closes the circuit as it leaves and touches the corresponding contact point which is firmly attached to the bell frame.

With the armature in the position shown there is a contact between these two points, hence the circuit at that point is closed; but the wire connections in the bell are such that when a current is sent through the magnet coils the armature is drawn toward the core in the usual manner, and the tongue following it causes

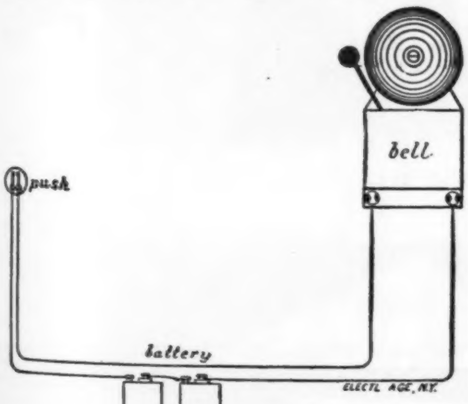


FIG. 2.—SIMPLE BELL CIRCUIT.

its contact point to leave the one on the bell frame. This breaks the circuit and causes the current flowing through the magnet coils to cease. The armature then flies back to its original position and closes the circuit again, which energizes the magnets once more, only to repeat the operation. The result of this cycle of changes is to cause a very rapid vibratory movement of the armature, and as the bell hammer moves with the armature it strikes the bell each time the armature is drawn toward the magnets.

At the lower corners of the frame are two binding posts to which the bell wires are attached (see Fig. 2).

Let us now trace the course of the current through the bell itself. Starting from the right-hand post, the current passes through the two magnets successively, then along the tongue piece at the back of the armature, through the contact points, thence to the other binding post, then out.

Fig. 2 shows a simple bell circuit complete, including the bells, battery, and push button.

Two cells of battery are generally used. Any open-circuit battery is adapted to bell circuits, and there are many good ones on the market, the Leclanche being the oldest and best known, and many think the most serviceable.

In connecting the battery with the rest of the system, one of the wires must be connected with the zinc

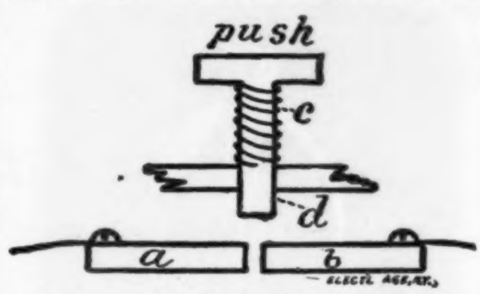


FIG. 3.—PRINCIPLE OF PUSH BUTTON CONSTRUCTION.

of one cell and the other wire with the porous cup of the second cell; and the porous cup of the first cell and the zinc of the second must be connected with a short piece of wire.

The wire connections must be tight and firm, otherwise considerable waste of current may occur. It is advisable to scrape the ends of the bare wire prior to making the connections, in order to remove any foreign substance thereon that might interfere with making a good connection.

Push buttons are as variable in form as bells are. Like the bells, however, they are all about the same in principle. A push button essentially is a device which provides for the closing of the circuit by the pressure of a finger or the hand, and when the pressure is released the circuit will open again.

Fig. 3 shows the principle of push button construction. a and b represent the wire terminals, which are

FIG. 4.—ORDINARY PUSH BUTTON.

slightly separated. When the push, d, is pressed down it comes into contact with the ends of the wire terminals and bridges over the gap, thus closing the circuit. As soon as the pressure or the push is removed the spring, c, restores the push to its normal position and opens the circuit in consequence.

The ordinary form of push buttons is shown in Fig. 4. The white central projection is the push, to which pressure from the finger is applied. The wooden case which screws on to the base covers and protects the mechanism, and at the same time admits of ready access thereto in case of necessity, by simply unscrewing the cap. Many push buttons are made of metal and handsomely finished.

Another form of push button is shown in Fig. 5. It is known as a "floor push," and is designed to be placed in a hole bored in the floor. This style is used principally in dining rooms, to call servants to the table, and is located within easy reach of the foot of the person sitting at the head of the table. It will be seen that it is in principle the same as a door push, the only difference being in form.

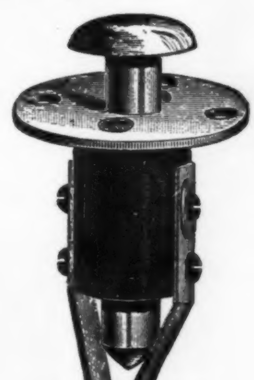


FIG. 5.—FLOOR PUSH.

Very frequently it is desired to arrange call bell wires so that the bell may be rung from the upstairs halls or from any room in the house, besides from the front door. Such an arrangement is shown in Fig. 6.

The various tap circuits are connected with the main wires in the manner shown, and the bell will ring when any one of the push buttons is pressed by the finger. These taps may be run to any part of the house desired, and such an arrangement saves a great many steps and a great deal of running up and down stairs. The two wires of each tap are connected with the main wires so as to form a bridge.

This method of connecting is called "multiple arc," and it is on account of the multiple arc connection that it is possible to ring the bell from different points. The taps are connected in multiple arc always, but there is one connection in a system of this kind that is not—it is the push button farthest away from the bell. All tap wires must invariably be placed between the end button push and the battery, and the battery must be

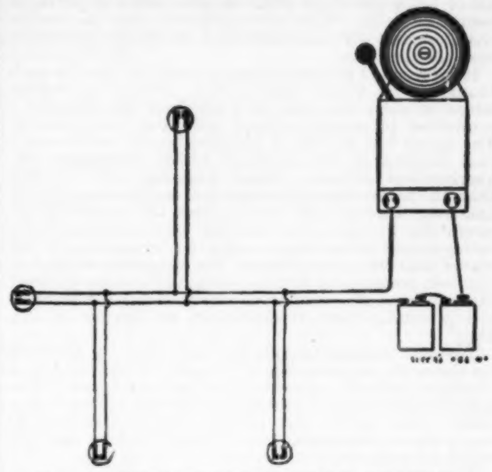


FIG. 6.—BELL CIRCUIT WITH BRANCH PUSH BUTTONS.

placed on the circuit at a point between the bell and the push button connection nearest thereto.

There are a great variety of ways of running bell circuits, and many others than those illustrated will suggest themselves to the student and amateur.—*Electrical Age.*

PENNY IN THE SLOT RAILWAY LAMPS.

THOUGH the question of providing a greater amount of light in railway carriages has for years past occupied the attention of railway managers, the illumination is, in most cases, no more than is required to enable the passenger to enter and leave the train in safety, while the possibility of reading in comfort is still out of the question.

To the Metropolitan District Railway Company belongs the credit of being the first to adopt a system of electric lighting which gives the traveling public just what is wanted, and at the same time admits of a satisfactory profit being made by the company undertaking the supply. This want is met by the railway electric reading lamp, invented by Mr. Tourtel for retailing electric light to passengers by pennyworths.

A few of these lamps have been experimentally in use on the Metropolitan District Railway for the past two years, and the results of the trials have been so satisfactory that a contract has been made by that company with the Railway Electric Reading Lamp Company, of No. 1 Great Winchester Street, E. C., to install up to 10,000 reading lamps in the carriages of the District Railway, and we understand that similar contracts are being negotiated with other railway companies.

It is not intended at present to displace the gas lamps in use in the roofs of carriages, but to provide a separate light for passengers desiring to read.

The mechanism of the lamp is exceedingly simple, and is contained in a box five inches by three inches. Upon introducing a penny into the slot at the top of the machine, and subsequently pressing a knob, an

electric light is obtained which burns for about half an hour, at the end of which time it is automatically extinguished, but can be relighted by the insertion of another penny. The light, which is of about three candle power, is concentrated by a shaded reflector, which may be turned within certain limits, so that the light may be directed to suit the position of the passenger. One of the most remarkable features of the instrument is its honesty, as it is so arranged that in the case of a failure in the supply of electricity, the machine automatically returns the coin to the operator. Another noticeable feature is that, should the lock of the apparatus be tampered with, a bell is automatically set ringing in the guard's van.

It is proposed to place these lamps under the hat

rails in railway carriages, so that the passengers seated in the corners, and thus furthest from the roof light, may be able to provide themselves with additional illumination. The whole of the lamps placed in one carriage are supplied with the electric current from an accumulator placed under one of the seats of the carriage, which is thus entirely self-contained, and capable of being detached from the train without the light being affected. The accumulators can be easily changed, and will be replenished at charging stations near the terminus.

It is intended that four lamps shall be fixed in each compartment, which makes from sixteen to twenty lamps in each carriage; and all these lamps will be connected in parallel circuit with the accumulator. The mains will be run in grooved boxing underneath that portion of the carriage which overhangs the longitudinal girders. Feed branches will be run from the mains through the floor of each compartment, and from these feeders branch wires will be carried beneath the lining of the carriage to each lamp, fuses being placed at each lamp and at the connection of the mains with the accumulator. The lamps are worked at the low pressure of twelve volts, and consume about three-fourths of an ampere. With this exceptionally low pressure, there is absolutely no danger of any kind.

The accumulator battery has been specially designed for the work, and consists of six cells, coupled in series, having a capacity of seventy-two ampere hours. The cells are inclosed in a strong wooden case, which is provided with rollers and handles for convenience in removal, and duplicate sets of accumulators are provided for each train.

The charging current will be about thirty amperes (*i. e.*, ten amperes through each set), at a pressure of about one hundred volts, while the power required will be only from sixteen to twenty horse power.

An authority upon electrical matters, as affecting railway companies, Mr. C. E. Spagnoletti, past president of the Institution of Electrical Engineers and consulting electrician to the Great Western Railway Company, points out the following, among other conveniences which this system offers to travelers: A good, steady light to read by; a light always at hand, and ready for use; no forethought required to provide lamp or candle (so often forgotten) before starting on a journey. This lamp enables the traveler to recline in any position and direct the light as desired, whereas with a roof lamp an upright position is necessary to get the light on the book or paper. Travelers are able to obtain a good light for reading without interfering with others who require less light and to sleep. Each carriage being independently lighted, these lamps will not be extinguished by severance of the train at junctions, when changing engines, or when taking off or putting on vehicles. A carriage can run over various railway companies' systems as a through coach, and these lamps will not be affected.

SOME SIMPLE SCIENTIFIC EXPERIMENTS.

Foucault's Pendulum.—At dessert, it is possible, by means of an apple or an orange, to repeat the Foucault pendulum experiment, which was executed under the dome of the Pantheon in 1851.

Pass a match through an orange and allow the ends to protrude on each side, and to one of these ends attach a thread.

Attach the other extremity of the thread to the head of a pin inserted in a cork, and support the latter by means of three forks, the handles of which rest upon the edge of a plate. Now cause the pendulum to swing after so regulating the length of the thread that the lower point of the match shall come very near the bottom of the plate and mark its passage in two small circular piles of powdered sugar, designed to represent the circle of sand that Foucault arranged upon the ground all around his pendulum.

The plate represents the earth. As long as it remains stationary, the match, at every oscillation, will pass

Fig. 1.—THE FOUCAULT PENDULUM.

exactly through the furrow that it has made in the two piles of sugar.

If, in order to represent the rotary motion of the earth, we gently revolve the plate, and consequently the forks and cork, we find that that has no influence upon the pendulum, which continues to oscillate in the same plane as before, and we have a proof of this in seeing the match at every oscillation make a small furrow distinct from the preceding. We can thus demonstrate in a simple and practical manner the principle of the invariability of the plane of oscillation of the pendulum, upon which was based the celebrated experiment of the French scientist.

The Revenge of the Danaides.—Fill two glasses of the same size, one with water and the other with red wine. Place upon the glass containing the water a small piece of bobbinet a little wider than the glass, and which has been previously moistened.

Turn down the excess of bobbinet around the glass. Apply the left hand flat to the edge of the glass thus prepared, grasp the foot of the glass with the right hand and quickly invert the glass in order to prevent the entrance of air as much as possible. Remove the left hand by sliding it very gently in a horizontal direction, and you will find, much to your surprise, that the bobbinet remains applied against the edge and holds the water in the glass (Fig. 2, A) without a single drop passing through the fabric.

Now place the glass, thus inverted, upon the glass containing the wine, which must be full to the brim (Fig. 2, B), and you will immediately see thin red fillets passing through the apertures in the bobbinet. It is the wine, which is rising progressively to the upper glass, and which is replaced by degrees by the water, which descends into the glass situated beneath. At the end of about ten minutes the exchange will be complete, and the lower glass will be filled with perfectly clear water and the upper one with pure wine.

The Bird in the Cage.—Draw upon a sheet of paper an empty bird cage, and, at a few millimeters therefrom, a bird. The question is to make the bird enter the cage. This is the way to do it: Place a visiting card between the two figures, holding it at right angles to the paper. Rest the end of the nose upon the edge of the card and look at the cage and the bird. You will thus see the cage with the left eye, for example, and the bird with the right. In a moment it will seem to you as if the bird were beginning to move, and as if you saw it enter the cage and occupy the position shown by dotted lines in the figure. The figure to the right will render it unnecessary for you to make a drawing. Place a card on the line, A B, and face the light so that the card will throw no shadow; then look for a few seconds and the phenomenon will occur. This simple experiment recalls to us the laws of binocular vision, that is to say, of simple sight with two eyes.

The Five-pointed Star.—The five-pointed star is called in geometry the regular starry pentagon. The construction of it with the ruler and compasses is too long and complicated an operation for us, who wish instantaneous geometry. Let us reject the ruler and compasses and take a simple band of paper and make a knot in it as shown in the two figures to the left of our engraving. Let us tighten this in holding the band of paper very flat, and then fold it according to the lines, A E and C D. We shall thus obtain the regular pentagon, A D C D E. If we fold the band so that its edge, C F, shall take the direction, C A, and place our pentagon before the window or before a light, we will see the five-pointed star that we wished to obtain.

The Sum of the Angles of a Triangle.—Take any triangle whatever, E A F (Fig. 5), cut out of paper. We are going to prove that the sum of the angles, E A F, A E F and E F A, numbered 1, 2 and 3 in the figure, is equal to two right angles. To this effect, let us first fold our triangle according to the line, A B, care being taken that the line, B E, shall be well upon the direction, B F. Let us lay our triangle flat, and let us remark that we have at the point, B, two right angles, E B A and F B A. Let us now turn down the three points of our paper triangle upon the point, B, in folding it according to the lines, C D, C G and D H. We see upon the figure that the three angles, 1, 2 and 3, are thus juxtaposed, and further, that they exactly cover the two previous right angles without the points overlapping each other and without there being any

Fig. 2.—EXCHANGE OF WATER AND WINE.

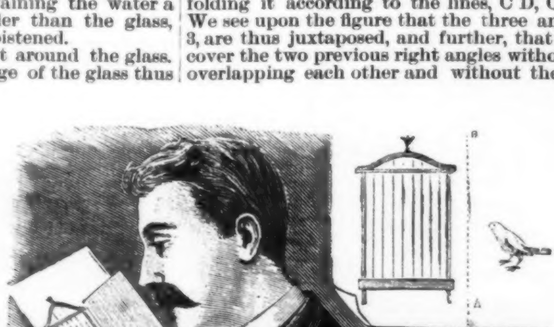


Fig. 3.—THE BIRD IN THE CAGE.

Fig. 4.—THE FIVE-POINTED STAR.

Fig. 5.—THE SUM OF THE ANGLES OF A TRIANGLE.

spaces between them. The sum of the three angles of our triangles is therefore really equal to two right angles.

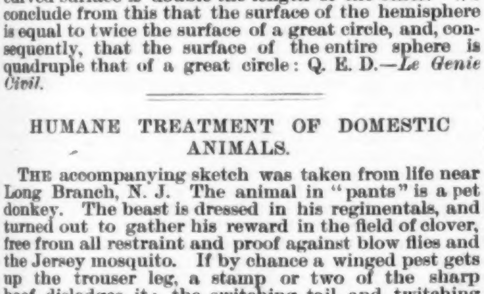
Surface of the Sphere.—We shall now demonstrate with just as simple materials, and without calculation, one of the most important theorems of geometry in space, viz., that the surface of a sphere is equal to four times the surface of a great circle. Let us saw any wooden sphere whatever through the center, and let us take one of the halves and fix a cord thereto by means of a nail inserted at the *pole* of the great circle, that is to say, at the point of the hemisphere that is highest when we place the flat part upon the table. Let us wind the cord around the nail as if upon a top, so that it shall exactly cover the entire curved surface of the half of the ball that we hold in the hand. Now let us stop and cut the cord at the place where we ceased winding it. Let us now take the other half of the ball and a piece of cord of the same thickness as the other. Let us fix its extremity by a nail driven at the center of the circle (which is a great circle of a sphere, since our saw passed through the center). Let us wind the cord spirally around the nail in keeping it flat upon the circle. Let us stop when the circle is entirely covered, and cut the cord at the place where we terminated. Let us now unwind the two pieces of cord, and we shall find that the piece wound upon the curved surface is double the length of the other. We conclude from this that the surface of the hemisphere is equal to twice the surface of a great circle, and, consequently, that the surface of the entire sphere is quadruple that of a great circle: Q. E. D.—*Le Genie Civil.*

FIG. 6.—THE SURFACE OF A SPHERE.

HUMANE TREATMENT OF DOMESTIC ANIMALS.

THE accompanying sketch was taken from life near Long Branch, N. J. The animal in "pants" is a pet donkey. The beast is dressed in his regimentals, and turned out to gather his reward in the field of clover, free from all restraint and proof against blow flies and the Jersey mosquito. If by chance a winged pest gets up the trouser leg, a stamp or two of the sharp hoof dislodges it; the switching tail and twitching ears amply protect all other exposed parts.

This protecting garb is by no mean a rough, ill-fitting makeshift, but is made from strong unbleached muslin cut as nearly as possible to fit the form. The edges are strongly bound with muslin to keep them from breaking out. The trousers are made rather wide, as shown in the cut, and are one-leg trousers: that is, each is separate from the other. On the inside of the leg they come up close to the body, and on the outside run in a tapering width to the backbone; by tapes and buttons the ends are fastened across the back. The outside covering is made precisely as a horse blanket, with the exception of the additional length for the neck and ears, and the additional strip underneath, running the length of the blanket from leg to leg and buttoned under the belly to a corresponding piece on the other side. While one's first impression is that the garb is ludicrous in the extreme, a second glance brings us to the point of admiration for the neatness of the outfit and the comfort of its wearer, which is heightened by the contented look in the animal's eyes as he lazily twitches his long ears. Surely a similar dress could be readily made up for the one cow and one horse of the small farmer or owner of a country home and be worth all it costs.—*Rural New-Yorker.*



A DONKEY IN PANTS.

APPARATUS FOR BOILING EGGS.

NUMEROUS apparatus have been invented for accurately measuring the time in boiling eggs, but none appears to be faultless. The little apparatus represented herewith, however, gives a solution of the problem. The external tin box is provided in front with a dial over which moves a hand. At the top there are four apertures, opposite each of which is inscribed one of the four degrees of boiling, very soft, soft, nearly hard, hard. At the moment that the eggs are immersed in the boiling water, a leaden ball is introduced through one of the apertures. The hand is then seen to move over the dial, and, at a given moment, the ball falls upon a bell, which announces that the eggs are boiled to the proper degree.

The mechanism of this apparatus is very ingenious. In the interior of the little clock there is a closed cylindrical box, A, movable around the horizontal axis that carries the hand. In order to render the apparatus more sensitive, the axis rests upon two small rollers. The cylindrical box carries at its summit four holes, H, for the leaden ball that are slightly eccentric on the side where the ball is to fall, and each placed at a different distance from the axis of oscillation. The lower part of the box carries a weight, P, that partially counterbalances the leaden ball. In the interior of the box there is a horizontal diaphragm beneath which is a liquid. This diaphragm, on the side at which the ball falls, is provided with a small aperture, and, on the opposite side, with quite a large one. When the ball is placed in one of the holes at the upper part it produces, on account of the eccentric position of the holes, an inclination of the box.

At this moment, the liquid, which forms a movable ballast, passes slowly through the small aperture in the diaphragm, thus displacing at every instant the center of gravity of the whole on the side at which the ball is dropped. At a given moment the equilibrium is broken, the cylinder revolves and the ball falls upon the bell, T, and passes into a receptacle, B, at the side, whence it may be taken for a new operation, the apparatus having put itself automatically in a state to

APPARATUS FOR BOILING EGGS.

work. In fact, as the fall of the ball has taken place, the weight at the bottom has righted the box, and the liquid that had passed at the upper part of the diaphragm has immediately returned to the bottom of the box in passing through the wide opening of the diaphragm.—*Les Inventions Nouvelles.*

EARLY RISING NOT ALWAYS A VIRTUE.

SAYS *Harper's Bazar*: "Thousands of people have no choice whatever about their hour of rising in the morning. Later or earlier, that hour is fixed for them by the requirements of the office, the shop, or the class room; by the time table of the railroad; by the arbitration of their employers or the necessities of their employes. But in the cases manifold where personal liberty is enjoyed, it should not be thoughtlessly restricted simply because of the domestic tradition that early rising deserves praise and late rising blame. Breakfast may often be a movable feast without materially disturbing the routine of an orderly housekeeping day. Invalids, mothers whose rest has been broken by teething babies, and, above all, rapidly growing children, should have their sleep out. Nature demands this, and violence is done to her when sleepy people are rudely aroused from their beds. Early to bed is the single safe prescription to insure early to rise.

"We need to repeat it over and over to our hurrying, anxious, toiling American men and women: Rest, rest, and again, rest. Do not think time ill spent that is spent in repairing the ravages of our well-nigh incessant activity."

ODORS AND THE SENSE OF SMELL.

By M. CHARLES HENRY.

A CONSIDERABLE number of mineral compounds are odorous. It is enough to mention, as illustrations of the fact, the sulphureted hydrogen odor of rotten eggs and the scent of hydrocyanic acid which emanates from bitter almonds. Although perfumes, or pleasant smells, are organic or carbon compounds, the distinction between organic and inorganic may be considered artificial, since the principal organic bodies can be obtained by the combination of such simple mineral elements as carbon, oxygen, hydrogen, and nitrogen. On the gradual complication of syntheses of this kind M. Berthelot, who has made more of them than any other chemist, has based a classification of organic compounds into eight categories. We have first, hydrocarbons, formed of the two elements—acetylene, formene, benzene, turpentine, styrolene, etc. The bodies composed of three elements—carbon, hydrogen, and oxygen—are divided among four categories. We distinguish between the alcohols, which are capable of uniting directly with acids to form ethers with the elimination of the elements of water; the aldehydes, which are formed at the expense of the alcohols, with the loss of hydrogen, among which are the essence of bitter almonds and the essence of cinnamon; the acids, like acetic and benzoic acids, which can unite with bases and form salts; and the ethers, the results of the association of alcohols, acids, or other alcohols, among which are the oils of the onion and of mustard. Among quaternary compounds we have the alkaloids formed by the union of the alcohols with ammonia or other alkalies, amides formed by the union of ammonia and acids with the separation of the elements of water; and the metallic radical compounds which are obtained by the reaction of metals on some of the ethers.

Perfumes are, in general, binary or ternary compounds characterized by the fact that the proportion of equivalents of hydrogen to those of carbon diminishes at the same rate as those of another class of products very rich in hydrogen which are called the fatty series, while this class of products, less rich in hydrogen, is called the aromatic series. Is there any relation between odor and chemical composition? An English physiologist, Mr. John Berry Haycraft, in his studies of the savors and odors, and savors of the principal compounds of each natural family of bodies, particularly of compounds of the family oxygen, sulphur, chromium, selenium, molybdenum, tellurium, didymium, tungsten, and uranium, has observed modifications in odor corresponding with increase in atomic weights. For example, sulphureted hydrogen, hydrogen selenide, and hydrogen telluride smell like rotten eggs. The compounds of elements of this family with methyl and ethyl have an alliaceous odor. So with the family chlorine, bromine, and iodine; the acids which these bodies form with hydrogen and their compounds with methyl, ethyl, and ethylene have similar odors, so that some among them seem to share them with their neighbors: bromoform, for example, having a similar odor with chloroform and iodoform. Passing to the organic series, Mr. Haycraft observes in the monatomic alcohols a modification of odor corresponding with variations in atomic weight. Methyl alcohol, for instance, has a weak odor of alcohol; ethyl alcohol has the typical alcoholic odor; propylic alcohol has both an alcoholic odor and a special smell; isobutylic, amylic, and octylic alcohols progressively lose the alcoholic odor and acquire as against it a special scent. The same facts are remarked in the fatty acids and hydrocarbons.

Similar odors may be furnished by bodies without likeness in chemical composition. Arsenic in oxidizing disengages vapors that have the odor of garlic. Nitrobenzene, benzoic aldehyde, and prussic acid smell much alike. It has been asserted that emeralds pounded and ground several hours a day for three weeks had emitted a well defined odor of violets. The fact has been verified; but it has yet to be determined whether it is due to the manipulation or to organic substances that have been released by the trituration. Sulphuric acid, combined with distilled water, disengages a pungent odor resembling that of musk. The odor of musk is brought out in a great many reactions. The nitrate derivatives of aromatic substances smell of it. Artificial musk and natural musk have no chemical resemblance. So alcohols chemically identical, but of different derivation, do not behave alike with essential oils. As odor is thus in a great measure independent of the chemical constitution, it must depend upon the disposition of the particles, a property which it is evidently impossible to discover by any known chemical processes.

A few eminent chemists, following Dalton, Avogadro, and Ampere, have tried to make up for this impossibility by hypothesis, and have taken up the great problem of predicting and explaining chemical combinations and isomeries. Their theories, called atomic, have been adopted in most of the original memoirs and taught in most of the text books. Whatever may be their scientific value, the aids they give him in retaining and recollecting the formulas present incontestable advantages to the student. The applications of them to the study of the aromatic series are famous.

The radical of the hydrocarbons of this series and of all the other compounds is benzene, a body composed of six atoms of carbon and six atoms of hydrogen; when it is attacked by a reagent, and we substitute for an atom of hydrogen another simple body or a group of atoms, whichever of the atoms of hydrogen the substitution may bear upon, we obtain a single product; whence it is concluded that each atom of carbon is united to an atom of hydrogen, and that a symmetrical exchange can take place of the atoms of carbon among their valencies. A German chemist,

Herr Kekule, has tried to express these peculiarities by a hexagonal scheme which has still some lack of symmetry, and M. Ladenbourg has substituted a prismatic scheme for it. In this figure the six atoms of carbon of the benzene occupy the summits of a triangular prism, each one being united with an atom of hydrogen and exchanging the three valencies that are left it with the three next atoms of carbon by the three edges which meet at the summit. The perfect symmetry of this scheme is well expressed in the simple construction of the figure. But usually, for greater convenience, the hexagonal construction is adopted, and the reciprocal relations of the atoms of carbon and hydrogen are represented by figures in which the more or less complex lateral chains are joined, and which offer the remarkable characteristic of being closed chains—that is, of always returning to their starting point. What the atomic theories have taught us concerning odor is limited to this singular and so far unfruitful representation; it is evident that they are still mute concerning the real structure of the molecular edifice. The efforts which have been recently made to fill this void are more difficult to expound and follow than fruitful in applications.

Six methods of extracting perfumes are known: The first is expression, by means of a special press, which is applicable without too great loss to fruit skins rich in essential oils, such as orange and citron peel, previously grated. Another method is that of distillation, which consists in heating flowers with water in a boiler. The essential oil is volatilized and is condensed with the vapor of water in a worm and a Florentine receiver. The water usually goes to the bottom and the oil floats. The oils of neroli, rose, patchouli, geranium, lavender, caraway, etc., are obtained in this way. This process is not applicable to the delicate perfumes of the mignonette and the violet; and for them recourse is had to maceration of the flowers in animal fats or mineral oils, which have the property of absorbing odorous substances, and are then washed in alcohol. The flowers are usually heated in the fat or the oil for a variable number of hours. For perfumes which cannot endure a high temperature the petals are placed between two frames of glass coated with fat. This is the process of *enfleurage*. The pneumatic process, which consists in causing a current of perfumed air or carbonic acid to be absorbed by coatings of lard on glass plates, appears not to have given satisfactory results. Another process consists in dissolving perfumes in very volatile liquids like sulphuret of carbon, chloroform, naphtha, ether, or chloride of methyl, and volatilizing the solvents, which can be done at a low temperature in a vacuum. The last method has given very satisfactory results in the extreme delicacy and great accuracy of its returns.

Series.	Types.	Secondary odors of the same series.
Rose	The rose	Geranium, eglantine, palissander.
Jasmin	The jasmin	Lily of the valley, ylang-ylang.
Orange	Orange flower, or neroli	Acacia, syringa, orange leaf.
Tuberose	Tuberose	Lily, jonquil, narcissus, hyacinth.
Violaceous	Violet	Cassis, iris, mignonette.
Balsamic	Vanilla	Balsams of Peru and Tolu, benzoin, storax, tonka bean, heliotrope.
Spicy	Cinnamon	Nutmeg, mace, allspice.
Caryophyllaceous	Clove	Pink.
Camphor	Camphor	Rosemary, patchouli.
Sandal	Sandal wood	Vetivert, cedar.
Citrine	Citron	Orange, bergamot, cedrat, lime fruit.
Herbaceous	Lavender	Aspic, thyme, wild thyme, marjoram.
Mint	Peppermint	Wild mint, basil, sage.
Anise	Anise	Anise-seed, caraway, dill, fennel, coriander.
Almond	Bitter almonds	Laurel, nut, mirbane.
Musky	Musk	Civet, musk mallows.
Amber	Ambergris	
Fruit	Pear	Apple, pineapple, quince.

Numerous classifications of odors have been proposed. It is, of course, impossible to quote any rational classification. The natural way is to group around a type, in successive series, odors which resemble one another. Eugene Rimmer has tried to do this in the accompanying table.

The author observes that it would be hard to arrange in any of these series certain peculiar odors like that of wintergreen, or salicylate of methyl and magnolia. Notwithstanding the uncertainties attending the arrangement, we must apparently depend upon classifications based upon this principle for a guide in the study of odors.

All that we know concerning the propagation of an odor is that it consists in an emission of solid, liquid, or gaseous particles. This emission is allied for these three states of matter to the property called diffusion, which consists in the reciprocal penetration at the end of a certain time of the particles of two or more bodies among one another; and also for solids and liquids to the property called volatility, or the rapidity of evaporation.

But little is known concerning the diffusion of solids. If we heat to a high temperature a porcelain crucible within a crucible of plumbago, the plumbago will penetrate the porcelain to a depth varying according to the duration of the experiment. M. Pellat has shown, by delicate measures of quantities of electricity, that metallic surfaces placed parallel to one another a few tenths of a millimeter apart reciprocally exchange their outer surfaces, as if they emitted a little of their own substance to each other. When the influence ceases, the surfaces gradually lose their foreign coatings, and return slowly to their primary condition.

The diffusion of liquids is easily observed. It can be witnessed by introducing, with a pipette, into a vessel under water a colored liquid, red wine, for example. The wine, being lighter than water, rises to the surface, and does not color the deeper layers of the water till after one or two days. There is doubtless in the complicated diffusion of liquids a kind of chemical action related to the movements on water of camphor and a considerable number of diffusible substances. If we put a bit of camphor on the surface of water, it at once turns round and moves in every direction. If a drop of oil is let fall on the same surface, the movements will cease immediately. The motion arises from the diffusion of camphor in a liquid form on the surface of water. When, after the surface is saturated, there is no more diffusion, the motions cease. They also cease when two currents are produced by different bodies in opposite directions. That there is a liquid diffusion is proved by the fact that when the camphor is placed on a float of pith, or on the polished surface of mercury, there is no movement. So, if a bit of camphor is put into a large saucer covered with a thin layer of water, the water immediately retires, sometimes for several centimeters, before the odorous substance. The laws of the diffusion of liquids may be summarized by saying that the rapidity depends on the nature of the substance, increases in proportion to the degree of concentration of the solution, and augments as the temperature rises. Graham's dialyzer is based on the very feeble diffusibility of certain substances, like the gums, and the great diffusibility of certain crystalline substances, like salt. It is simply a vessel, the bottom of which is formed of a leaf of parchment paper, that lets the diffusible substances pass into the water around it and holds the others.

The diffusion of gases and vapors, which is more important in questions of smell, is subject to laws which have been only approximately determined. A glass tube about a meter long is used, divided perpendicularly to its length by a thin metallic partition, which can be made to slide between two perforated glasses. A gas is introduced into each of the separated halves of the tube; the supply cocks are closed, the partition is lifted out, and the two halves of the tube are put in communication; a half hour later the partition is shut, and the gaseous mixture contained in each of the compartments is analyzed. Mr. Loschmidt has in this way found the mathematical rule for the measure of the diffusion of different gases, one within the other.

The volatility of a liquid is expressed by the weight of that liquid which evaporates per second and per square millimeter at a given temperature. All that is known of it is that this weight is proportioned to the excess of the maximum tension of the vapor at that temperature over the tension which it has in the air; and this weight varies inversely as the atmospheric pressure according to a law special for each liquid. Evaporation may, therefore, give us valuable information concerning the purity of the odor, and spare us, in many cases, the delicate problem of determining the maximum tension which is so important a characteristic of substances. A special apparatus has been devised for the rapid measurement of volatility.

Tables have been prepared showing the relative volatility of different perfumes, of the substances used for adulterating them, and of the adulterations, by means of which a convenient method is afforded for the detection of frauds.

The influence of different physical forces on the disengagement of odor has been studied; and possible relations between the colors of flowers and the intensity of their perfumes have been inquired into. It has been found that white flowers represent the largest number of odoriferous species, and after them come red, yellow green and blue. The order corresponds with that of the emission of calorific force. Flowers which by their color emit the most heat also emit the most perfume.

The results of the study of the influence of the color of substances on their power of absorbing odors differ a little from these: white, yellow, red, green, and blue absorb odors in a decreasing order, or rather emit them in an increasing one. These colors represent decreasing luminous powers.

Ozone develops the energy of essential oils, and perfumes in turn determine by their oxidation in the air the production of ozone. This is a matter of hygienic significance, for the presence of ozone being favorable to health, we have a means at hand of increasing the supply of it by surrounding ourselves with fragrant substances and flowers.

Heat favors the volatilization of perfumes, and to such an extent that beds of flowers are sometimes inodorous in the bright sunlight which are fragrant in the shade. Some essences need a high temperature for the production of their full effect; while others, to have their delicacy fully appreciated, require the coolness of the evening. This principle may account for apparent differences of tastes among the people of different countries. The odors of many substances are not of equal strength in different climates. Prof. Tyndall believes that there are considerable differences in the absorbing power of different odorous vapors for radiant heat. He perfumed small paper cylinders by dipping them by one end in an aromatic oil, and then placed them in a glass tube, which communicated, through a stop cock, with a tube in which a vacuum is produced. The air, according as it has been perfumed with one substance or another, discloses to the galvanometer an absorbing power, which, air at the usual pressure being taken as one, varies from thirty for patchouli to three hundred and seventy-two for anise seed. These results are, unfortunately, not exact, for no account is taken in them of the tensions of the odorous vapors, which certainly vary, though they are probably of very small absolute value.

Messrs. Nichols and Bailey have compared the smelling powers of men and women. Having made measured solutions of a number of essential oils, a series of flasks was prepared so that the solution in each succeeding one should be only half as strong as that in the preceding one. The flasks were "shuffled," and the subjects of the experiment were called upon to rearrange them in the order of concentration of the solutions. The smelling power of women appeared to be on the whole less delicate than that of the men. The extreme delicacy of the scent of the dog is well known. Mr. Romanes has shown that, by fastening a sheet of paper to the shoes, the odor may be masked, and the dog prevented from following the track of his master; but that a contact with the ground of a few square millimeters is enough to enable the dog to follow the scent. In birds the sense of smell appears to be little developed; in mollusks and insects the smelling apparatus has been located in the antennæ. Below the group of worms, no olfactory reactions have been, so far as I know, definitely established.

The mechanism of the olfactory apparatus is, as a whole, simpler than that of sight and hearing; but the sensation is subordinated to many individual anatomical peculiarities. As much can be said of touch and taste, which require contact of the excitant, while sight and hearing merely register the vibrations transmitted by a medium. It is easy to conceive how the condition of the membranes, the form of the nasal passages, etc., may affect the sensation.

A distinction is made in medicine between respiratory anosmias, which depend on the formation of the organs and the condition of the connective tissues, and essential anosmias which result from atrophy of the nerves. Anosmias are frequent; some are congenital, many are senile and temporary, and connected with traumatisms, hemianæsthesia, aphasia, and hemiplegia. We cannot expect to find as concordant reactions for the smell as for the sense of color or the sense of form. It is nevertheless a matter of interest to investigate, on as good subjects as we can get, the influence of different odors on sensibility; or, in other words, to determine the weight of odorous vapor which it is necessary to breathe and accumulate in the nasal fossæ to make a perfume perceptible. That is the purpose of olfactometers. The olfactometer gives, besides this, the intensity of a perfume. The larger the perceptible minimum of a perfume, the less intense the perfume is, and it is this intensity which determines the price of a perfume, the delicacy of its odor being the same.

The olfactory sense is followed by effects of different kinds of intensity from those of sight and hearing, and may be accompanied by a kind of poisoning. The old medical books are full of stories of it. There are those of a girl killed by the exhalations of violets; of a woman seized with a violent headache from sleeping on a bed of roses; and of a girl who lost her voice by smelling of a bouquet. Ancient medicine attributed curative properties to perfumes, particularly to those of the rose, musk, and benzoin. The intensity of the effects of perfumes makes a rapid succession of sensations, almost impossible; for consecutive odors cause a rapid anæsthesia of the sense; on the other hand, if the times separating two successive sensations are too long, it becomes impossible to combine them, and the anticipated effect is disturbed by strange feelings. In short, smell is rather the complement of other excitations than an artistic excitation like a melody or a picture. Its function is, nevertheless, very important. By virtue of its volatility it is a valuable prophylactic; by the great intensity of its effects it can bring about salutary modifications of physiological functions, particularly of the amplitude of respiration; and it possesses in the highest degree the luxurious character of every artistic enjoyment. Flavor has an essential part in nutrition; so has touch. Hearing and sight are indispensable to relations with other persons; but smell, necessary to the animal for finding its prey and avoiding danger, has become, under normal conditions an almost useless sense to man, since the refinements of civilization tend to prevent the production of miasms and the pestilential odors from which he has to protect himself. It is therefore becoming more and more a sense of luxury for civilized man; and that, perhaps, is the reason why poets, from the author of the Song of Songs down, have associated all kinds of beauty and joy with perfumes.—*Revue Scientifique; Popular Science Monthly.*

ANALYSES OF WHITE SANDS.

INVESTIGATORS who undertake experiments on vegetable nutrition on a small scale, growing the plants in boxes or bottles, are interested in finding a medium of cultivation which is as free as possible from fertilizing principles.

As we have frequently been asked for information on this subject, we have thought it useful to publish the following analyses carried out during the last few years at the agricultural station. These analyses give the composition of the sand as washed on the large scale and dried in the air; further washings would lead to a still higher degree of purity.

	Sand from Roeulx (Havre).		Sand from Tilly (Marbais).	
	Fresh.	Dry.	Fresh.	Dry.
Water	54·30	—	43·07	—
Organic matter	0·38	0·40	0·90	0·94
Lime	0·09	0·10	0·02	0·02
Magnesia	0·02	0·02	0·05	0·05
Oxides of iron and aluminum	0·07	0·07	0·77	0·80
Potash	0·01	0·01	0·13	0·13
Soda	0·03	0·03	0·10	0·10
Phosphoric acid	0·03	0·03	0·03	0·03
Sulphuric acid	0·02	0·02	Traces	Traces
Sand and silica	945·05	999·32	954·93	997·93
	1,000·00	1,000·00	1,000·00	1,000·00

The organic matter contained:

Nitrogen per 1,000	0·005	0·005	0·002	0·002
Weight of a liter	1·400 kilos.		1·500 kilos.	

CALCAREOUS RESIDUES FROM SUGAR EXTRACTION.

The analysis of the deposits from sugar extraction given in the principal treatises on fertilizing materials (Heiden, Wolff, Muntz, etc.) attribute to this waste product a percentage of nitrogen varying from 0·2 to 1. In our table "average composition of fertilizing materials" we also fixed the richness of this material at 0·8 per cent. of nitrogen, as a mean of numerous analyses. Since almost all the sugar works have completely changed their process of manufacture this number is actually much too high. The publication of the following analyses is therefore of interest to those who are using this calcareous fertilizer. They show the important change which has taken place in the composition of this substance; they apply to fresh material exposed to the open air, coming from different works in which the diffusion process is used. No. II. is an average sample produced in 1891–92, at a sugar works in the province of Lugi.

	I.	II.
Water	49·63	38·47
Organic matter	4·42	4·85
Mineral "	45·95	56·68
	100·00	100·00

The organic matter contains:

	I.	II	III	IV.
Nitrogen	0·10	0·09	0·18	0·09

The mineral matter was composed of:

	I.	II.
Lime	24·65	30·80
Magnesia	1·49	0·57
Potash	0·51	0·07
Phosphoric acid	0·47	0·61

The average strength in nitrogen, of the samples analyzed, is therefore only 0·12 per cent.

In spite of this important diminution, this material is still of value as a fertilizer, and is not sufficiently appreciated by a large number of farmers.

The application of 40,000 kilos. per hectare would restore to the soil, in round numbers, 50 kilos. of nitrogen and 200 kilos. of phosphoric acid, in a very good form.

This amount corresponds to 2,000 kilos. of wool waste, containing 2·5 per cent. of nitrogen, and to 1,200 kilos. of a 13 per cent. superphosphate, without including the amount of potash present. There remains to be considered the beneficial effect of this quantity of finely divided calcium carbonate upon the physical properties of the soil, on the nitrification of the nitrogenous organic matter, on the decomposition of the double silicates, and at least in acid soils on the saturation of the free organic acids.

MARL FROM NIVELLES.

The deposits of marl, so abundant in Belgium, have never yet been made the object of an analytical examination undertaken to ascertain their fitness for agricultural use. We propose to supply this lacking information by publishing, from time to time, analyses of the various deposits of the country, commencing with those of Nivelles.

	I. From the boundary of the Haut. Ithe. Air dried.	II. From Baudemont. Air dried.
Water	5·12	4·79
Lime	22·61	22·90
Magnesia	0·47	0·60
Potash	0·31	0·19
Soda	0·64	0·20
Oxides of iron and alumina	1·43	1·10
Carbonic acid	17·62	18·27
Sulphuric "	0·01	0·01
Phosphoric "	0·01	0·04
Sand and silica	51·78	51·90
	100·00	100·00

These numbers show that the deposit is rich enough to be worked with advantage where the deposits are not deep. Its calcareous and silicious nature renders it very suitable for improving strong soils.

QUINITE.

SINCE Maquenne proved inosite to be a sixfold hydroxylized hexamethylene, it was to be expected that the hydroxyl derivatives of this substance which are poorer in oxygen would possess sugar-like properties. Baeyer has now succeeded in reducing the *p*-diketone of hexamethylene by means of sodium amalgam to the glycol of hexamethylene. To purify it, he converted it into the diacetyl derivative and this on saponification with barium hydrate gave the pure glycol, $C_6H_{12}O_2$. It is cistrans-paradioxy-hexamethylene and resembles in appearance and behavior a sugar of the mannite group. It is permanent toward permanganate solution and Fehling's solution, tastes at first sweet and then bitter.

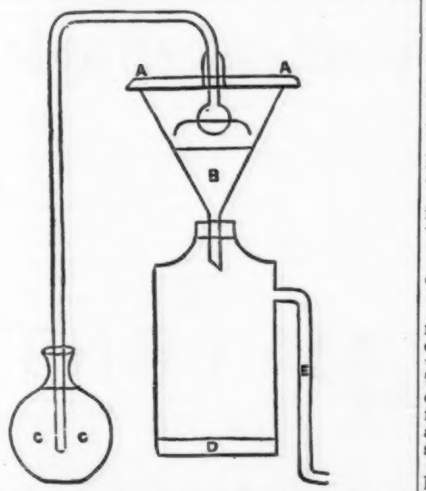
It is easily soluble in water and alcohol, fuses at 143°–145°, and distills without decomposition. According to its formation it is a hexahydro-hydroquinone, and in that case would afford on heating with chromic acid quinone. Since it possesses sugar-like properties and is the simplest representative of the inosite group, the author proposes for it the name *quinite*. The preparation of this substance opens the way apparently for the production of other hydrobenzene compounds.—*Ber. Berl. Chem. Ges.*, xxv., 1,037, March, 1892; *Amer. Jour.*

APPARATUS FOR WASHING PRECIPITATES.

By MATTHEW FORBES.

THE following simple apparatus for the washing of precipitates will be found to be of much advantage, especially when washing gelatinous ones:

Procure a lead disk about ¼ inch thick and a little larger than the funnel that is used, with a true face



A. Lead and rubber disks. B. Precipitate and fluid. C. Washing fluid. D. Filtrate. E. Tube leading to filter pump.

and a projection on the center of the other side, with a hole bored through (5/16) to admit of a piece of glass tubing passing easily through; then blow a small bulb on one end of the tube and pierce four small holes with a needle through the side of it while held in the flame; then get a disk of the thinnest India rubber and punch a hole smaller than the glass tubing, and pass tubing through both disks and projecting beyond the other side, and slip on a piece of India rubber tubing to embrace both glass tubing and projection on lead disk; and to the other end of rubber tubing connect a convenient length of tubing to be led into a flask or jar of the washing fluid to be used.

Now throw precipitate into funnel with ground face and wash it down on filter paper as much together as possible, and leave a little more fluid in funnel than you wish to have during washing. Now moisten the disks with water, and place on funnel, pressing firmly down and round a little, and start filter pump; the result of which will be that as the fluid is withdrawn from funnel the washing fluid in flask will pass over to replace it (if all the joints are air tight), and will now wash as long as you choose, simply by keeping flask supplied with washing fluid, and leaving one free to work at something else.

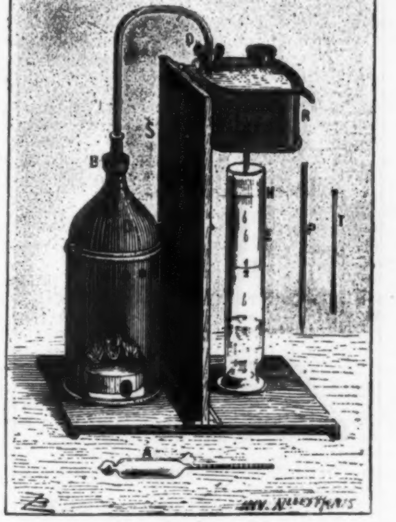
The apparatus washes very quietly and does not disturb the precipitate, the fluid acting more as a series of layers of fluids passing through precipitate.

In the event of the small bulb dipping into the fluid in funnel, lift out tubing from the flask before stopping filter pump, as otherwise some of the precipitate might be carried back to flask when filter pump is stopped.

The accompanying sketch will give a clear idea of the apparatus.—*Chem. News.*

A NEW LABORATORY STILL.

THE quantitative analysis of wines, beers, cider, and other fermented liquids can be effected in an accurate manner only by distillation, which separates the alco-



NEW LABORATORY STILL.

hol from the other elements. The strength of the alcohol is then determined by means of an alcoholmeter, the use of which necessitates a distillatory apparatus of appropriate size. The still figured herewith fulfills the requisite conditions.

Upon a furnace heated by a lamp with three burners, L, is arranged an alembic, C, of copper, tinned internally. A jacket prevents loss of heat. The wine or other liquid to be tested is introduced into the alembic after having been measured in the test glass, E, and brought, by means of the pipette, P, exactly to the level of the top mark of the glass. The test glass is then rinsed with a small quantity of water, which likewise is introduced into the alembic. The latter is then closed with the bayonet catch, B, which compresses an asbestos washer and renders the joint hermetical. The neck, D, is fixed by means of a screw coupling to a worm inclosed in the elliptical refrigeratory, R. The product of the distillation is collected in the test glass, and when the liquid reaches the level of the line marked ⅓, the distillation is arrested.

In the first place, the liquid collected is brought to the primitive volume submitted to experiment by the addition of water. To this effect, the water is introduced with precaution, care being taken not to reach the mark at the top of the glass. The exact filling is finished with the pipette.

After shaking the mixture, the readings of the alcoholmeter and thermometer immersed in the liquid are carefully taken.

A simple reading from a table that accompanies the instrument gives the alcoholic richness of the liquid with perfect accuracy.—*Les Inventions Nouvelles.*

THE CONCENTRATION OF OIL OF VITRIOL.

THERE are many different forms of platinum apparatus employed in this country, and in Europe, for concentrating oil of vitriol, in the construction of which a good deal of ingenuity has been displayed. The older form of still, consisting substantially of a deep, flat-bottomed retort, has been superseded by newer forms of apparatus more or less elaborate, and all of which attempt to fulfill certain requirements, considered necessary for economical work.

Of these newer forms of apparatus, Prentice's pans have been largely adopted, and have for many years yielded satisfactory results. It is generally admitted that the economical principle involved in the construction of these pans originated with Faure and Kessler, who conceived the idea, and, we believe, first adopted it in practice, by constructing the platinum evaporators so that the acid would be exposed in thin layers to the influence of the heat. Rapid ebullition and quick concentration were thus obtained, and also increased output per unit weight of platinum used. Faure and Kessler employed shallow flat-bottomed vessels, while Prentice introduced the same type of vessel, but with corrugated bottoms, whereby the heating surface of the pan was increased. The apparatus, as a whole, may be considered one of the best of its kind, as it is cheap, efficient, and an economical evaporator.

The system of concentrating O. V. in Prentice's pans is somewhat elaborate in its arrangement. It consists essentially of one or two corrugated platinum pans, a platinum boiler or still, and a series of leaden pans in which the weak chamber acid is heated, and partly concentrated, before it passes through the platinum apparatus. The shallow platinum pans with corrugated bottoms are about 24 in. long by 18 in. wide, and 5 in. deep, and have a V-shaped groove running around their edges. A leaden hood, covering each pan, rests in these grooves, the joint being luted by the products of distillation, which condense on the inner surface of the hood, and flow into the grooves. To the side of each cover or hood a draught pipe is attached, which serves to carry away the products of distillation. The acid, after it has passed through these pans, flows into a flat-bottomed still or boiler, as it is usually called, about 60 in. in length by 18 in. wide, and made entirely of platinum, where it is concentrated to the required degree. From thence it is cooled by passing through a series of long bottle-shaped platinum tubes, immersed in cold water, before it is finally stored in carboys. A platinum arm, bent at right angles, one end of which is fixed to the dome of the boiler, while the other is inserted into a platinum tube, about 7 ft. long and 2½ in. in diameter. This tube carries away the weak acid vapor evolved during the last stages of concentration. The long tube here mentioned is surrounded by a water jacket, after the manner of a Liebig's condenser. The water jacket is, of course, supplied with a constant stream of cold water, entering at the lower end, and passing out more or less heated at the other.

The leaden pans are heated by the waste heat passing away from beneath the platinum vessels. They are constructed of strong sheet lead, 16 or 18 lb. to the foot, and of such a size that the total heating surface corresponds to about 30 square feet per ton of oil of vitriol made per 24 hours. They vary in depth from 15 to 18 inches, and are connected together by means of small overflow shoots. The corrugated platinum vessel receiving the hot partially concentrated O. V. from the last (hottest) leaden pan is placed almost immediately above the fire, and when two such pans are used the flame or fuel gas passes direct from beneath one to the other, the two pans being in close proximity, and in a direct line with one another. A brick fire bridge is placed in the flue (which in itself is not very deep) beneath these pans, and below the end nearest the fire, in order to cause the flame to dart upward against the bottoms of the pans, and thus induce violent ebullition. The flame is usually severe, and with this arrangement the firing is hard and requires constant attention. The final concentrator or platinum boiler is placed immediately in a line with these pans, and, of course, receives the hot fuel gases or flame, as the case may be, after it has passed from beneath them. From thence the fuel gases pass under the leaden pans, through long flues, containing baffling walls, and so arranged that the waste heat first of all circulates beneath the leaden pan containing the hottest and strongest acid, then beneath the others in the series, before finally passing away to the chimney.

The acid from the chambers flows through the leaden pans in the contrary direction to the flow of the fuel gases. It enters the back or weakest pan, and then through all the others in succession. It then passes into the first corrugated pan, then through the second (if two are in use), and lastly through the platinum boiler, from which it flows continuously through the platinum cooling apparatus into the carboys or other store vessels. The back leaden pans, viz., those which first receive the acid, simply heat it, little or no concentration taking place in them. As it flows through the others toward the platinum apparatus, it increases in temperature and specific gravity, and a very appreciable concentration takes place in those nearest the fire. The vapors arising from the hot acid are almost invisible, and contain practically no acid. There is therefore no necessity to cover them. In no case does the acid actually boil in these pans. When this happens (due probably to local overheating) the chemical action of the acid on the sheet lead gives rise to excessive local wear and tear, sulphate of lead is rapidly formed, the acid becomes "milky," and a hole is quickly worn through the sheet lead. The presence of sulphate of lead in the acid or "milkiness" is a sure indication that the lead is being dissolved. When the strong pans become overheated this generally takes place, and to guard against it manufacturers protect the bottoms of these pans with an arrangement of layers of tiles, sand and cast iron plates amounting in the aggregate to several inches in thickness, so that any rapid increase in the temperature of the flues beneath will not rapidly affect the leaden bottoms. When a pan becomes milky active steps are at once taken to cool the acid, and, of course, the pan itself.

The following figures represent the temperature and specific gravity of the acid expressed in degrees of Twaddell's hydrometer, in a series of six leaden pans working on this system, and with brimstone O. V. run direct from the chambers:

	Temperature. Fah.	Twaddell @ Tem. of Pan.	Twaddell @ 60° Fah.
	Degrees.	Degrees.	Degrees.
No. 1 Pan	160	106	116
2 "	220	101	117
3 "	249	102	121
4 "	260	104	125
5 "	280	107	129
6 "	283	113	135

The strength of the acid entering the system varies, of course, with the mode of working the chambers, and the specific gravity above given may be considered rather below the average of manufacturing practice. When working O. V. made from brimstone, the chamber acid is never concentrated in the Glover tower, but frequently when pyrites acid is to be made the chamber O. V. is passed down the Glover tower into store tanks from which it flows direct into the platinum apparatus. This acid is contaminated with arsenic, iron, and selenium, etc., all derived from the pyrites, and these impurities deposit in the platinum pans,

causing frequent stoppages for cleaning and other trouble.

Pyrites acid is now largely purified by precipitating the arsenic as sulphide with sulphureted hydrogen, and for this purpose the chamber O.V. is frequently diluted with water to a suitable strength before the removal of the arsenic can be accomplished with certainty. The arsenic, moreover, exists in chamber O.V. in the state of trioxide and pentoxide As_2O_3 and As_2O_5 respectively. It is well known that the latter oxide is more difficult to precipitate with sulphureted hydrogen than the trioxide, and means are sometimes adopted to reduce the higher oxide to the lower state before precipitating the arsenic as sulphide. Any dilution of the acid before purifying represents at first sight so much more fuel consumed in its concentration, but as a matter of fact, the amount of waste heat passing away from the platinum pans and boiler allows a certain latitude in extending the system of leaden pans, so that the diluted vitriol (say 90° Twaddell) may be concentrated before reaching the pan corresponding to No. 1 of the above series, and thus the expenditure of extra coal is avoided.

The following figures relating to the work done by such a system, concentrating brimstone vitriol, are compiled from results obtained in actual practice. The acid from the strongest leaden pan registered on the average about 290° F., and a sp. gr. of 1·70 (=140° Twaddell) at 60° F. The O.V. of 168° Twad. finished per shift of 12 hours amounted to 8,750 lb., equal to about 50 carboys (10 gallons capacity) each containing 175 lb. acid. The strength of the concentrated acid is given as 168° Twad., but in reality it seldom comes so high as this—usually 165° to 166° Twad. The reason of this is well known. The coal consumed per day of 12 hours amounted, on an average, to 16 cwts. 3 qrs. 10 lb., which includes that used for heating up. This gives a consumption of coal equal to 37·8 lb. per carboy of acid made, or 4·65 lb. O.V. were concentrated per lb. of coal used.

The distillate from the first platinum pan is practically water vapor containing only small traces of acid. It is usually allowed to escape into the atmosphere. That, however, from the second platinum pan is stronger in acid, and is conducted by a leaden pipe to the vitriol chambers, where it is used instead of steam.

The strength of the acid boiled off in the platinum boiler and condensed in the Liebig's condenser varies a good deal: it is chiefly controlled by the work of the leaden pans. If the acid leaving these pans is below 140° Twad. (cold), then the distillate condensed in the platinum tube is about 90° Twaddell; but if it be maintained at that strength, the average distillate will reach as high as 110° Twaddell. There are other conditions which control the strength of this weak acid, such, for example, as the nature of the firing, whether it be hard or medium. Excepting the presence of hyponitric acid, and this, it may be remarked, is seldom found in it, this acid is very pure when obtained from brimstone O.V. It is stored in large earthenware vessels and concentrated by itself in glass retorts for laboratory and pharmaceutical purposes.—*Chemical Trade Journal.*

THE SOLUBILITY OF THE PHOSPHORIC ACID OF BONE MEAL.

By H. Otto.

The consumption of bone meal in the west of Germany has declined so much during the last two years that producers find it difficult to dispose of a good product even at low prices. The cheapness of superphosphates, and especially the extraordinary demand for basic slag meal, are the principal causes.

Probably no manurial substance has given rise to so many publications and theoretical researches as basic slag. In P. Wagner's memoirs on this subject the phosphoric acid of basic slag is almost without exception represented as superior to the phosphoric acid of other manures. It is in the first place remarkable that in Wagner's comparative manurial experiments the efficacy of bone meal takes so low a relative position. In these experiments it seems to have resulted that the phosphoric acid of bone meal scarcely occasioned an increase of the crop, and that its efficacy was always less than that of the phosphoric acid of basic slag.

Quite opposite views are put forward in the publications of Prof. Marek, of Konigsberg, and Prof. Holdefleiss, of Breslau. The latter, in his treatise on "Das Knochenmehl, seine Beurtheilung und Verwendung" (Bone Meal, its Valuation and Use), says (p. 168), referring to the experiments of Marek: "According to these decidedly trustworthy results bone meal has a considerable manurial value, so that it may be included among the most certain and efficient manures. This conclusion is the more trustworthy, as it agrees with the practical experience of many decennia and is fully confirmed daily."

These contradictions can scarcely be accidental, and I can only assume that the bone meal used in Wagner's experiments was not a good product. The chief part of the bone meal at present met with in commerce is produced from bones which have been freed from fat by means of benzine. The meals are either simply ground bones or mixtures of bone meals freed from glue, and so-called "stamp meal," obtained in the manufacture of granulated bones. Of the mixtures of horn meal, blood meal, crude phosphates, and a little bone meal, which unfortunately are also met with in trade, I am not about to speak. These occur now less and less frequently since several experimental stations have declared an energetic war against them.

The bone meal obtained from bones deprived of fat contains always from 4¾ to 5 per cent. nitrogen, and 21 to 23 per cent. phosphoric acid (P_2O_5), rarely more than 2 per cent. of fat, generally less; all bone meals containing less than 4 per cent. N and 20 per cent. P_2O_5 are not purely degelatinized meals, or the entire substance of the bone has not been used in their manufacture.

It is remarkable that such a bone meal, which, according to Heyden, Holdefleiss, Marek, etc., is an excellent manure, should prove inert according to Wagner.

When the basic slag in the state of meal was especially recommended to farmers as an especially effective phosphoric manure, it was sought to prove the solubility of the phosphoric acid by means of Wagner's citrate solution. In fact, the phosphoric acid of basic slag, if ground sufficiently fine, is to a great degree soluble in this citrate.

In the conviction that a bone meal almost deprived of fat must give up its phosphoric acid to a slightly acid solution of ammonium citrate, I examined various samples of bone meal exactly according to Wagner's citrate method as laid down on December 19, 1885, and found that according as the meal had been more or less finely ground from 8·05 to 9·15 per cent. of the P_2O_5 was rendered soluble, or from 38·28 to 41·30 per cent. of the total weight of the meal.

From these results it is clear that the phosphoric acid of bone meal freed from fat, but not from gelatin, is very readily soluble. If we consider further that on account of the large percentage of gelatin the solubility in the soil will be increased by the products of decomposition formed during decay, we may assume with certainty that such bone meals must possess a considerable manurial value.—*Chemiker Zeitung; Chem. News.*

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